ENVIRONMENTAL ASSESSMENT BOARD

Ontario

ONTARIO HYDRO DEMAND/SUPPLY PLAN HEARINGS

VOLUME: 123

DATE: Thursday, March 26, 1992

BEFORE:

HON. MR. JUSTICE E. SAUNDERS	Chairman
DR. G. CONNELL	Member
MS. G. PATTERSON	Member

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(416) 482-3277

2300 Yonge St. Suite 709 Toronto, Canada M4P 1E4

ENVIRONMENTAL ASSESSMENT BOARD
ONTARIO HYDRO DEMAND/SUPPLY PLAN HEARING

IN THE MATTER OF the Environmental Assessment Act, R.S.O. 1980, c. 140, as amended, and Regulations thereunder;

AND IN THE MATTER OF an undertaking by Ontario Hydro consisting of a program in respect of activities associated with meeting future electricity requirements in Ontario.

Held on the 5th Floor, 2200 Yonge Street, Toronto, Ontario, on Thursday, the 26th day of March, 1992, commencing at 11:15 a.m.

VOLUME 123

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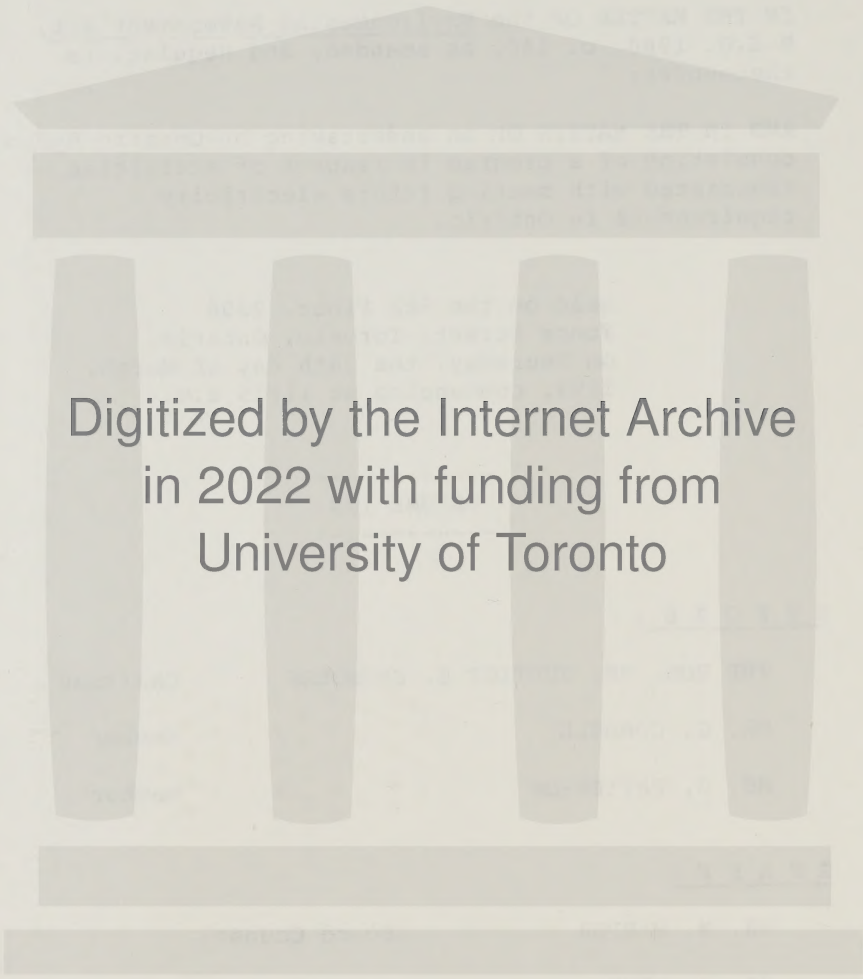

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L I S T o f E X H I B I T S

L I S T o f U N D E R T A K I N G S

TIME NOTATIONS

---Upon commencing at 11:15 a.m.

THE CHAIRMAN: We have had before us this morning a motion brought by Energy Probe with respect to the sufficiency of the answers to certain interrogatories submitted to the proponent.

In general, the issue concerns the relationship between Ontario Hydro and its regulatory agency, the AECB. Energy Probe has asked that Hydro provide all correspondence or minutes of meetings or records, or of any other exchanges between Ontario Hydro and the AECB on a number of issues set out in the notice of motion, including such matters as mercury wetted relays, seismic qualifications of Darlington "A", environmental qualification retrofits for post accident reactor operations, and other safety issues.

The issue raised by the motion is first of all the relevance of the material requested, and second, the extent of the level of detail that is appropriate or would be of assistance to this Panel in determining the issues that are before it.

On the matter of relevance, it is quite clear to us that safety of nuclear operations is a critical issue that must be considered as part of the hearing process, and within that context it seems to us that the history of the relationship between the

regulatory body and the proponent may be of some significance.

The whole issue of the safety of nuclear generation was considered in what has become known as the Ontario Nuclear Safety Review, the Hare Report, which reported in February of 1988.

While we want to make clear that we do not necessarily adopt the findings of that report and that the issues that are contained therein are still open issues, it does provide an analysis of the relationship and refers to it.

The extent of the detail requested by the interrogatories seems to us to be too broadly based. On the other hand, we think that Energy Probe and others ought to have some information on which they can base their cross-examination and their cases which relate to the relationship between the regulatory agency and the proponent.

The problem is to somehow or other in a practical manner draw the line between excessive request for detail and that which is necessary to enable the parties to assist the panel in making the determination it has to make.

Ontario Hydro has provided extensive detail on these issues to the parties; however, we

think it would be helpful both to the panel and to Energy Probe and the others if an update, a summary of the relationship on the safety issues raised by Energy Probe from the date of the Hare Report to the present could be provided.

We would expect - although this may be a wrong assumption - that someone like Mr. King would be able to prepare such a summary in a fairly short time, being a matter in which he has been heavily concerned.

So, if we can leave it at this point that there should be a summary of the relationship on those issues since the Hare Report with any documents which Hydro thinks should accompany that in order to make it clear to us and to others what that relationship has been, that would be helpful and we would like that done.

Now we can proceed with the cross-examination of AECL.

MR. HEINTZMAN: Thank you, Mr. Chairman, Members of the Board.

THE CHAIRMAN: I see Ms. McClenaghan and Mr. Poch on their feet.

Mr. Poch?

MR. D. POCH: I just wanted to make mention of the fact that I filed Exhibit 525 this

morning, the Nuclear Power Hazard Report.

---EXHIBIT NO. 525: Nuclear Power Hazard Report.

THE CHAIRMAN: I just want to say one more thing as occurs to me, that is I recognize this is a rather general request and what should happen as has happened in the past, there should be some consultation between the parties as to the practicalities of doing it, and then if that can't be resolved, then it will have to come back to us and we will have to give you some more direction.

Yes, Ms. McClenaghan.

MS. McCLENAGHAN: Thank you. That should be satisfactory. We just wanted do ensure or ask if your direction includes a reflection of the parties' original position on each issue as well as final result when you referred to a summary of the relationship in each issue.

THE CHAIRMAN: No, I am not thinking for a very detailed summary. I think that will give you a basis for further investigating those things which you feel you should investigate further and perhaps being satisfied on others. I think maybe it's a starting point rather than a finishing point.

MS. McCLENAGHAN: Yes. Thank you, Mr. Chairman.

MR. HEINTZMAN: Mr. Chairman, Members of the Board, I will be addressing some issues with your permission, and Mr. Hamer will be addressing other issues. Ms. Findlay will assist each of us as we progress.

I would just like to give you an idea of the issues that I will be dealing with, it's not intended to be comprehensive but a general picture of the subjects that I will be dealing with.

I will be dealing with the history of CANDU development; I will be dealing with the international aspects of nuclear generation and comparisons; thirdly, I will be dealing with nuclear generation's role in the DSP and the Update; fourthly, with Darlington; fifthly with retubing; sixthly with Ontario Hydro's OM&A record; then I will be dealing with a subject called load following; I will be dealing with a subject which I will call the assessment of risks associated with nuclear generation, although Mr. Hamer will be dealing with safety and health and any degree of detail, any treatment that I deal with risk will be as an overview and he will deal with the details.

As a ninth subject matter I will be dealing with CANDU 6 and CANDU 3, and as a tenth

subject, the timing for the design and building of nuclear generation facilities.

Again, none of those are intended to be written in stone either as to numbers or order, but that's a general outline of where I am going.

One thing I would say is that we had requested to be further down the list of examiners and we are pleased to lead off at the Board's direction, but it may be that subject matters raised by other intervenors will deal with subject matters particularly in the areas to be dealt with by Mr. Hamer upon which AECL would have helpful information which could be put to this panel. So it may be that we will ask to ask further questions after other intervenors particularly in the areas of health and safety if those become dealt with by other intervenors.

THE CHAIRMAN: Well, that's a procedural issue. Perhaps I should just make some comment on that so that there may be no misunderstanding.

[11:25 a.m.]

In a civil case, which this is not, the parties cross-examine in the order in which they appear on the proceedings. In this case we have tried to work out the order of cross-examination in an appropriate way. One does not normally and certainly there is no

right to re-open a cross following the cross-examination by other parties.

However, my experience has been when I have multi-party defendants that I will permit a restricted cross-examination. By that I mean that it not only must be something that has been raised in a subsequent cross-examination but also that it could not reasonably have been dealt with in the main cross-examination. So that the person who seeks to re-open cross has got to satisfy those two tests.

So on that basis, I think that's the way we -- I recognize that when there are a great number of cross-examiners, particularly on the kinds of issues that we have here, that there could be something that comes up later which as you say there may be some information which could be helpful to us.

The overall consideration is that we want to get the information that we need to help us solve these problems.

MR. HEINTZMAN: I appreciate that. And the operative word is "reasonable". It would be possible for us to chase down every avenue of inquiry, notwithstanding that it is not considered by others to be relevant, so you will appreciate in preparing a cross-examination, you try to whittle down and not

whittle up, and we have done that. So if matters are dealt with in other intervenors' questions, that may be the position that we will ask to assert.

Now if I may turn to the panel, I have a feeling, Mr. Penn, that most of my questions will be directed through you and to a lesser extent through Mr. King and Mr. Daly, and I think Mr. Hamer will probably be speaking more to Mr. Johansen and Dr. Whillans, so I will direct my questions mostly I think to you Mr. Penn, but I rest assured that if anybody wants to add their views that they will do so.

Now, Mr. Chairman and Members of the Panel, do we have the qualifications of the witnesses before the Tribunal? Do you all have copies of their qualifications.

THE CHAIRMAN: I do.

MR. HEINTZMAN: And if it would be more convenient to mark the qualifications as an exhibit, Mr. Chairman, or could we take them as....

THE CHAIRMAN: I think they have been filed as part of the witness statements. We have them.

MR. HEINTZMAN: Fine.

THE CHAIRMAN: We have the ones that were prepared and submitted by Ontario Hydro.

MR. HEINTZMAN: That's the one I am

working from.

DAVID WHILLANS,
KURT JOHANSEN,
FRANK CALVIN KING,
WILLIAM JOHN PENN,
IAN NICHOL DALY; Resumed.

CROSS-EXAMINATION BY MR. HEINTZMAN:

Q. And if we look to yours, Mr. Penn, you have been with Ontario Hydro since 1977, as I understand it?

MR. PENN: A. That's correct.

Q. And before that you were with Canadian General Electric in nuclear generation design or construction?

A. Yes.

Q. And before that with the Nuclear Power Group in England?

A. Yes.

Q. And I see from your qualifications that on the left-hand side it says generation approvals department. Does that apply to both nuclear and other kinds of generation?

A. It applies to the conceptual and definition phase of nuclear, hydroelectric and fossil.

Q. Right. And would the same apply to generation planning services?

A. Generation planning services provides

schedule and cost information.

Q. Again for those three types of generation?

A. For those and for other services required by the Corporation.

Q. And then I see fossil project planning. Now what does that involve?

A. That's a section involved with the conceptual and definition phase of fossil engineering.

Q. So you have a more direct involvement in fossil development because of that, do I take it?

A. I have an involvement in the project management and coordination of engineering issues.

Q. Concerning fossil generation?

A. Yes.

Q. And can I just get an idea of your involvement in the preparation of the DSP, Exhibit 3. Were you involved in conceptual ideas or actual preparation of the DSP?

A. No. I was only involved in providing engineering and technical information.

Q. So that if we were dealing with engineering and technical information in the DSP, you were involved in that?

A. I was involved in providing data to

our planners.

Q. In terms of the Update, would the same be true? Or did you have any involvement in the Update?

A. I didn't have any personal involvement in writing the Update.

Q. Did you do anything in terms of the Update? Did you provide any information to those who prepared the Update?

A. We would have provided financial or cost information that was relevant to the extended period that new generation was required.

Q. Other than that, did you have any involvement in the Update?

A. No.

Q. We will be talking to some extent about the CANDU A project which was terminated, I believe, in 1990.

A. That's correct.

Q. And that was a project to prepare the conceptual designs and ideas for another 4 by 881 nuclear station; is that correct?

A. That's correct.

Q. Were you involved in that?

A. Yes.

Q. Mr. King, we have got your qualifications before us. Can you tell me what your involvement was in the DSP.

MR. KING: A. I had no involvement in the DSP.

Q. And were members of your department, the risk departments, involved in the DSP?

A. Members of my section, which is the risk assessment section, were not involved.

Q. And in the Update is the same true?

A. The same is true.

Q. And in the CANDU A project?

A. No, I don't recall any involvement on the CANDU A project.

Q. Mr. Daly, I think we have your qualifications adequately. Can you just fill me in on what involvement you had in the original DSP.

MR. DALY: A. Well, as I described in my direct evidence, my section provides a number of forecasts, short-term, mid-term and long-term forecasts, and this is on a continuing basis. So, the system planners would take the latest forecast we had produced at the particular time and that went into the earlier DSP and the Update.

Q. So, we find forecasts of costing or

what?

A. Sorry, this is just forecasts of reliability.

Q. Reliability in the DSP would come from your department?

A. We would provide them. System planning would use them as they felt best in the Plan.

Q. And were any such studies prepared for the Update?

A. For the Update they took the latest forecast available at the time the Update was being prepared.

Q. So that there was no specific reliability studies for the Update other than normal yearly forecast?

A. For my point of view, that is essentially correct. They took our current forecast, yes.

Q. And in terms of CANDU A, were you involved in the CANDU A project?

A. My only involvement in that was there was one document early on which was sent to operations for review. It was a very general early document and we reviewed and commented on it, so essentially a very minor involvement which stopped pretty quickly.

Q. And Dr. Whillans and Mr. Johansen, can you just tell me your involvement in the DSP or the Update or the CANDU A project. Maybe we can start with you, Mr. Johansen.

MR. JOHANSEN: A. I didn't personally have involvement in the DSP or the Update. My department obviously was involved, but the department's contribution to the DSP was coordinated by a different unit that was supervised by someone other than myself.

Q. Is that in the case of the DSP?

A. Yes.

Q. Did your department have any involvement in the preparation of the Update? That you can think of.

A. Some, some. But I can't say exactly how much. Again it was coordinated by a different unit.

Q. What unit was that?

A. That's the planning and programs unit.

Q. And who is the head of that unit?

[11:35 a.m.]

A. Mr. Murray Patterson.

Q. And have you seen any materials that were produced by that unit for the purpose of the

Update?

A. Not for the Update. I haven't actually seen material that they produced for the Update, no.

Q. Do you know if they actually produced any materials for the Update?

A. I am only aware through discussion, but I really don't have any factual information on that.

Q. Do you know whether or not they produced any material for the Update, that particular department or unit?

MS. HARVIE: Mr. Chairman, the witness has just answered the question.

MR. HEINTZMAN: He said that he received some information, as I understood it.

MR. JOHANSEN: I didn't receive information. I'm aware.

I mean, discussion amongst staff, you get to know a lot of things. I was aware that people in that other unit were preparing some input to the Update. That's about the extent of my knowledge.

MR. HEINTZMAN: Q. And in terms of the CANDU A project?

MR. JOHANSEN: A. Yes, there were again

people from the major projects unit, again a different unit of the department, who were involved in that before it was stopped.

Q. Dr. Whillans, can you tell me what your involvement in those three projects were?

DR. WHILLANS: A. My only involvement is in providing some technical to Exhibit 507. I was not involved in the plan itself or the Update.

Q. And the CANDU A project?

A. Not at all.

Q. And were members of your department involved in the preparation of the DSP or the Update?

A. No.

Q. Okay. Now, I would like to perhaps go back with you, Mr. Penn, and I want to trace the origins of Ontario Hydro in CANDU technology.

What I would like to do is start, Mr. Chairman, Members of the Board, with a document which I would ask to be marked as an exhibit, entitled Nuclear Sector Focus, 1991, A Summary of Energy Electricity and Nuclear Data.

THE CHAIRMAN: Which reminds, I had forgotten about Mr. Poch's exhibit. We have to put that on the record.

MR. D. POCH: I don't if the reporter

took note. Mr. Lucas has an exhibit entitled Nuclear Power Hazard Report, and it was assigned No. 525.

THE CHAIRMAN: Thank you.

THE REGISTRAR: This one is now 526.

THE CHAIRMAN: Thank you.

---EXHIBIT NO. 526: Nuclear Sector Focus, 1991, A Summary of Energy Electricity and Nuclear Data.

MS. HARVIE: Perhaps I could make submissions at this point, Mr. Chairman, before Mr. Heintzman gets into in his questions about this particular exhibit. I would like to address the question of what these witnesses are here to address, if I may.

THE CHAIRMAN: Are you taking objection to a question Mr. Heintzman has asked?

MS. HARVIE: No, I am not talking objection to any questions yet, but I would like to put my concern on the record because I certainly intend to be objecting when he is asking questions about the planning choices that were made in preparing the DSP or the Update, or asking these witnesses about matters on which you have already considerable evidence from previously witnesses.

THE CHAIRMAN: Why don't we wait until there is a problem and then raise it then.

MS. HARVIE: Certainly, I will do that if you like.

MR. HEINTZMAN: Q. What I would like to do, Mr. Penn, if you could have Exhibit 43 in front of you at the same time, because this a document in which Ontario Hydro for the purposes of the ONCI inquiry sets out Ontario Hydro's involvement in the CANDU technology. And if we can have both of these together, I think we can trace it.

Do you have that document as well?

MR. PENN: A. Yes, I do.

Q. Perhaps we can start at page F-15 of this document.

Mr. Chairman, if could have an exhibit number after Mr. Poch's exhibit.

THE CHAIRMAN: We got it. 526.

What page?

MR. HEINTZMAN: Page F-15.

Q. And if we turn to that page at the bottom left around corner, it's my understanding that Ontario Hydro's first involvement in the CANDU technology started in or about 1954 when a partnership was formed with AECL and CGE to start to build Canada's first nuclear power plant which is called, as I understand it, the NPD.

MR. PENN: A. I would like to comment, Mr. Chairman, that I haven't seen this document before, but I have the right page, and I do recall from memory that that partnership was established about 1954.

Q. So that it's fair to say that Ontario Hydro was involved in the development of CANDU technology from the very beginning, virtually from the very beginning?

A. It is reasonable to say that, yes.

Q. Yes. And then if we look at the Ontario Hydro presentation to ONCI at page 13, paragraph .4, the same point is being made, I think, where it says:

> When Canada decided to proceed with its first heavy water moderated nuclear generating station in 1985, a vertical pressure vessel design was adopted. This was called NPD-1, nuclear power demonstration.
>
> In 1957 the decision was made to cancel NPD-1 and a new concept using pressure tubes in a horizontal reactor was committed in 1958 called NPD-2, and went into service in Ontario Hydro in 1962.

The next sort of development, is that NPD, the NPD-2 was started and designed in '55 and went into service in 1962.

A. Those designs you are referring to were developed by Canadian General Electric. NPD-2 was owned by Atomic Energy of Canada Limited, and under an agreement with Ontario Hydro, Ontario Hydro operated the plant.

Q. Yes. And it was a unit that was delivering electricity to the Ontario grid?

A. Yes, it did.

Q. Right. And we see that referred to on page F-15 of Exhibit 526 under the date of 1962. And in the meantime, as I understand it, in 1960 work had begun on the prototype nuclear generating station to be located at Douglas Point.

A. Yes. Atomic Energy of Canada, assisted by Ontario Hydro at AECL's offices started work in designing the Douglas Point reactor in 1960.

Q. Yes. And then that unit began production on what date? I am not clear as to when the Douglas Point unit started actual generation.

I see on page 13 of the ONCI exhibit, Exhibit 43, it went into service in 1968.

MR. DALY: A. That's correct. October

1968. Sorry, September 1968.

Q. And was that unit operated by Ontario Hydro?

MR. PENN: A. Yes, it was.

Q. Owned and operated by Ontario Hydro?

A. My memory is a little hazy on whether it was jointly owned by AECL, the provincial government of Ontario, and Hydro, but I am not sure about that.

Q. And those two units, the NPD unit and the Douglas Point unit were the units that really -- were the foundation of the technology which enabled Pickering to be started as the next stage of Ontario Hydro's development of nuclear generation?

A. Well, NPD and Douglas Point were the prototype CANDUs developed by Canada and subsequently adopted by Ontario Hydro amongst other utilities.

Q. Yes.

A. The others being New Brunswick and Hydro Quebec.

Q. And if we look then at Exhibit 526, we come forward to 1964, that's when Ontario Hydro announced plans for the 1,000 megawatt nuclear generating station to be built at Pickering. That would be correct, would it?

A. Yes. There was definitely an

agreement there, a three-party agreement for the building of the first two nuclear reactors at Pickering "A" and the agreement was between the Province of Ontario, Atomic Energy of Canada Limited on behalf of the federal government, and Ontario Hydro.

Q. And then in 1968, as stated on page F-15 on page 526, Ontario Hydro announced plans to build the Bruce generating station. Would that be correct?

A. I don't remember whether that was a formal announcement or whether that was the start of conceptual studies, I'm sorry, I can't confirm that.

Q. And then in 1971 Units 1 and 2 at Pickering began operating. Would that be approximately correct?

A. That's correct.

Q. And then in 1972, Unit 3 at Pickering?

A. That's correct.

Q. And if we turn over to page F-16, in 1973 Unit 4 at Pickering?

A. I can't confirm whether it was 1973 or 1974, but it was within that period.

Q. And Exhibit 526 says that with that unit coming on line, the Pickering station was

producing more electricity than any other nuclear power station in the world. Would that be a fair statement?

A. I believe it would be correct for a single site.

Q. 1974, announcement of another four-unit station at Pickering; is that approximately correct?

A. I think I could confirm that's when Hydro proceeded with conceptual studies.

Q. As we see there, at the same time site preparation began for the CANDU 6 units in Argentina and Point Lepreau.

I take it that Ontario Hydro has kept abreast of the development of CANDU 6 units or CANDU units elsewhere in the world?

A. We have.

Q. And then in 1977 Units 1 and 2 at Bruce "A" went into operation, is that approximately correct?

A. Yes.

Q. And Unit 3, it states here, and we will coming back to this, had the highest capacity factor in the world. That would be a fair statement at that point in time from your recollection?

A. I can't confirm whether it was Unit

3, but certainly in that period Ontario Hydro stations had, I believe, seven out of the ten in the world were the highest capacity. That sort of period of time.

Q. And then if we go on to 1987, just to note on the way through, in that year the CANDU technology received the honour of being included in the top ten Canadian engineering achievements in the past century; is that correct?

A. That's correct.

Q. And if we can go back to Exhibit 43, on page 14, under paragraph 3.6.2, it states that Ontario Hydro has been a major participant in the development of CANDU for the 33-year period from 1955 to 1988. That's a fair statement from the history we have reviewed?

A. Yes.

Q. And in paragraph 3.6.6, and we will be coming to this in detail during my examination, Hydro's satisfaction with CANDU nuclear is based on the wide experience with alternative electricity sources. And you will that they are referring in paragraphs .3, .4 and .5 to hydraulic, fossil and purchasing from other utilities.

That's a fair statement in paragraph. 3.6.6?

[11:50 a.m.]

A. I am not quite sure what the authors of that particular paragraph had in mind. But as a base load electricity generating supply system, Ontario Hydro certainly has in the past been satisfied with its performance.

Q. And remains satisfied?

A. As given in our testimony and Mr. Daly's, in particular, we have expressed concerns and we have taken action about declining performance in our "A" stations, and our target is to bring them back to where they were.

Q. Yes. And we will be coming to this in considerable detail. The concerns that Ontario Hydro has had arise primarily out of the effect which declining OM&A expenditures has had upon the performance of the stations. Is that a fair statement?

A. The constraints on OM&A were certainly a significant factor in the performance.

Q. And if we look at page 15 of Exhibit 43, we can see in numerical and graphic form the time that it has taken for each of the stations to be brought into service. Do you see that?

A. I can see the dates that were originally planned for in-service; I can see the dates

for the actual in-service date; and then a column second from the right that is headed Lateness Actual Minus Revised Plan.

Q. Yes. And in the final column, as I understand it, we have Elapsed Time Actual Minus Committed Years and that's the column I think that tells us in each case how long it took to bring these stations on from the time they were started?

A. That is what we call the lead time, I believe from this table, from the date that each of these projects was first committed.

Q. Now that's the point I am going to ask you to help me on. As I understand it, these dates in the right-hand column do not include conceptual planning, environmental approvals and that sort of thing. For instance, there have been no environmental approvals for or at least by the Environmental Assessment Board for any of these units, so these times on the right-hand side would not include time necessary for environmental assessments?

A. I don't believe those dates include the time to prepare the environmental assessment documents, but I would point out to you that environmental assessment documents were certainly prepared for Darlington and submitted to the Minister

of the Environment for their review.

Q. But no environmental assessment process such as this hearing or a public hearing of any nature occurred with respect to those projects. That's fair; isn't it?

A. No public hearing on those environmental assessments was required by the Minister.

Q. Yes. So that to the extent that that kind of process involves additional time, one would clearly have to add that time to these numbers if one was to compare the time for bringing such a station into service with or without an environmental assessment?

A. That's correct.

Q. And can you tell me, sir, whether the dates committed here refer to the placement of concrete or the date that someone first said, let's think about having a Pickering "A" or Darlington or Bruce unit? I spent quite a bit of time trying to figure out that distinction amongst various documents and I hope not to show you as many as I would have to to get at the point, but as best I can tell these dates are dates of first concrete or thereabouts. Can you help me there?

A. I can't be sure. It would be my view that -- and our usual definition of the word

"committed" is when we have received Order-in-Council from our government to proceed.

Q. Yes. And in order to get to that stage, you would have had to have done a considerable amount of work to develop the concept and, to the extent that you did in those days, develop environmental assessments and go through all of that process before you would get such an approval?

A. We would do what were called definition phase studies.

Q. So that the dates that we see here do not include any definition phase studies to the best of your knowledge?

A. That would be my belief.

Q. And running our eyes down the right-hand side, we can see that Pickering "A", starting in a date committed of October 1964 to the actual in-service date of July 1971, took .8 years more than expected and ended up taking 6.8 years to bring into service.

A. Yes.

Q. And we can look down these various numbers. In the case of Pickering "A", the fourth unit, the number would be from October '64 to April '67, when I assume that there was a lag time in giving

the approval to go forward with the fourth unit at Pickering?

A. The two pairs of units at Pickering "A" were separately committed. And the second pair, Units 3 and 4, according to this table were committed in April 1967. The first date refers to the intent, I imagine, to commit all four stations, but the actual dates were when the first two units were committed.

Q. I think if we look at the number of 8.7 and 7.6 on the side, on the right-hand side, we will see that those are referable to October 1964, but we can do that mathematically ourselves. If we look then to Bruce "A", we can see that the units there took from 8.8 to 10.2 years to take from the date of commitment as you defined it to in-service date?

A. Yes.

Q. And in Pickering "B" from 8.8 to 11.7 years?

A. Correct.

Q. And Pickering "B" 9.3 to 11.6?

A. Yes.

Q. And Darlington from 12.8 to 14.6 years?

A. That is correct for the actual in-service date expected in 1988 when this Exhibit 43

was written.

Q. And we know of course when we look down the actual in-service dates for Darlington where we see April '90, September '89, May '91 and February '92, that those dates were long over extended?

A. They have been extended, yes.

Q. And we will be coming back to this in some detail, but a considerable portion of that time was due to delays at the direction of the provincial government or Ontario Hydro management. Is that fair to say?

A. As I stated in my evidence yesterday afternoon, there were five occasions when there were scheduled delays.

Q. In other words purposeful delays, not something that happened in the course of construction that extended the time to these periods?

A. Correct.

Q. So that what we can see here, and we are going to look at some international data that will confirm this, that the time to construct a nuclear generating station has been considerably extended since the 1960s.

A. Yes it has for a number of reasons.

Q. And can you give us the reasons that

have caused the kind of extension in times of completing a nuclear generation station?

A. I don't know if I could list them all off the top of my head, but as we have marched down this list, the size of reactors and plants has considerably increased. The regulatory requirements, particularly for seismic reasons, and other reasons associated with hurricane protection and aircraft protection and many other features of that nature have increased. The main reasons for the increase is -- and new sites of course have been developed. Darlington in particular, the time involved in that table includes three years to prepare the site. The site at Pickering took a much shorter time.

Q. The degree of regulatory scrutiny, the degree of technical sophistication, everything is more difficult, more complicated than it was in the 1960s. Is that a fair statement?

A. I think it is a fair statement to say that much more information is now expected and required of these plants. I don't know if I would agree that it is necessarily significantly more complicated.

Q. And would you agree with me that that trend towards scrutiny and what not is expected to continue? In the future we can expect increased

scrutiny, increase of all the factors that have led to the time periods to construct a nuclear generation station to increase?

A. We expect that scrutiny from the Atomic Energy Control Board as one regulator, for example, will certainly continue at its current level.

Q. And therefore that we can expect that this trend is not likely to be reversed?

A. Correct.

Q. And perhaps we can look to Exhibit 526. There is a useful chart to that effect at tab C-14. And perhaps you would just like to look at that while I describe it, as I understand it. If you went back to the 1955 to 1960 period, the average time to construct a nuclear generation station was in the order of 42 months and by 1989 the average time to construct a nuclear generation station had reached 120 months or 10 years. Is that a fair statement of the trend as you understand it from an international perspective of what is happening with respect to the development and construction of nuclear generation stations?

A. As I mentioned, Mr. Heintzman, this is the first time I have seen this document and I am quite sure that there are numerous reasons for the variation in time shown on figure 2 in different

countries around the world, which I believe are listed in table 11.

Q. Yes.

A. All I can comment, Mr. Heintzman, is that it is generally the trend for increasing times to construction but I can't comment on the detail presented here.

Q. The detail is consistent with your understanding of the trend in terms of time of construction of nuclear generation stations? It is getting longer and longer?

A. There are jurisdictions where it's getting longer. It certainly has got longer in Ontario. But there are other jurisdictions where it has tended to stabilize or get shorter. Japan is a good example of that.

Q. Well, for instance, if we look across Table 11 opposite Canada, which you will note is highlighted, it shows going from 48 months in the period 1961 to '66, to 62 months, to 65 months, to 91 months by the time we get to 1983 to 1987.

[12:05 p.m.]

That would be consistent with the information you have about what is occurring in Canada?

A. Yes.

Q. And we can look along the bottom of the schedule to get the international trends, and you are quite right, if you look across Japan, you can see the number 52 in 1961 to 1966 is not going up significantly, and that would be reflective of your understanding of what is going on in Japan?

A. Yes.

Q. If you would go back with me to page C-1, I would like to review the international picture as it presently stands in development of various kinds of nuclear generation, and you will see on table 1, pages C-1 and C-2, a list of the generating stations around the world as of the end of 1990, indicating that you will see Canada with 18, four under construction, and if you turn to the bottom, 426 nuclear power reactors in operation as of the end of 1989, December 31st, 1989.

Now you have some data in Exhibit 519 which is of the same order. Is that a basic reflection of where the world stood in terms of nuclear power reactors as of the 1989 time period?

A. Yes.

Q. And if we look at page C-5, we can get an idea of where the largest distribution of nuclear generating capacity is in the world, and we can

see that, for instance, in the United States, perhaps not well-known, that 31 per cent of the world's nuclear generation is located in the United States. Would that be a correct number to your understanding as of that time period?

A. The table shows world capacity, and I would agree that there is more capacity in the United States than in any other country, but not necessarily more generation.

Q. Yes. In France, a considerable amount of the world's nuclear generating capacity is in France, as we there, 16.5. Is that in your line with your understanding?

A. Well, I haven't seen the numbers expressed this way before, but certainly France has a major nuclear program.

Q. And Canada as we can see has, according to this document, about 4 per cent of the world's capacity; as of that date would that be a correct number?

A. I believe it would, yes.

Q. Can we turn to page C-7, and I want to discuss with you the difference between the PWRs, BWRs and the PHWRs.

The PWRs are the pressurized water

reactors?

A. Correct.

Q. The BWRS are the boiling water reactors?

A. Yes.

Q. And the PHWRs are the pressurized heavy water reactors, i.e., the CANDU reactors?

A. Yes.

Q. And we can see that as of this date, December 31, 1989, there were about 239 PWRs in the world, 88 BWRs and 27 PHWRs.

Would that be a good number as of about that date?

A. Well, I can't vouch for the exact accuracy of those numbers, but I would expect that they would be in that range, yes.

Q. Is it fair to say, and I gather this from your testimony, that the three types of reactors that are really vying for acceptability and customers are PWRs, BWRs and the CANDU reactor?

A. That's correct.

Q. And right now the game is wide open and it is very competitive to secure a portion of that market.

A. Yes. From my consultations and

visits with major vendors and world utilities, I would say that's correct, yes.

Q. I want to come back to that subject in some detail.

If you turn with me to page C-16 to 18. On those pages there is a presentation of the proportion that nuclear generation bears to total generation, electrical generation. For instance, in Canada you will see on table 12 about 15.6 per cent of electrical generation was by nuclear power reactors in 1989; is that a fair statement?

A. Well, that's certainly what the table says. I am afraid I can't vouch for the exact nature of that number, but it's in the right order.

Q. And that would be a product of the fact that in Canada we have an abundance of hydraulic generation unlike most other developed countries.

A. That's correct.

Q. And on figure 3 we can see on page C-18 the growth in the share of nuclear power's proportion of world electricity generation. And again without getting into the numbers, is it fair to say that historically the share of generation by nuclear power has been increasing?

A. Yes.

Q. Now, I would like you to turn with me to tab G, and we are going to be looking at other international analyses of these numbers.

The ranking of nuclear reactor performance, which we see on table 1 of G-1, is something that utilities are very conscious of when they have nuclear generation; is that a fair statement?

A. Yes.

Q. And to some extent these load factors that we will be looking at can be misleading because some utilities use nuclear generation for what I understand is called load following; that is, they don't just run the reactors full out, but if the load falls off, then the reactor is moved down to an intermediate load mode; is that a fair statement?

A. The only country I am familiar with that practices that is France.

Q. We will look at some documents that I think shows that other countries do that.

But is it fair to say that Ontario Hydro has the capacity and has got the techniques to practice load following?

A. We can load follow down to about 55 per cent power.

THE CHAIRMAN: I'm sorry, I didn't hear

that.

MR. PENN: We can load follow, that means, Mr. Chairman, we can reduce the output of the units from 100 per cent to 55 per cent power approximately without what we call poisoning-out the reactor through xenon poison. Although we do have means to override xenon in a period of 24 hours.

MR. HEINTZMAN: Q. We will look at some charts and whatnot that show using CANDU reactors down to 40 per cent capacity. I take it it is possible to do so?

MR. PENN: A. I think it is possible, yes.

Q. And has Ontario Hydro used their nuclear stations in that mode, that is not down to 40 per cent but to load follow?

A. To my knowledge, and maybe Mr. Daly can help me, we have load followed with our Pickering units, I am not familiar that we have done it in the last year or two.

MR. DALY: A. We have not done a large amount of load following but we have done some from time to time.

The unit that we have used, Mr. Penn is correct, in the early years we used the Pickering units

primarily, in the last few years we have been using the Bruce "B" unit to manoeuvre and we have had occasions to take it down to 40, 50 per cent power at Bruce "B".

Q. The word manoeuvre is another word that is it used in your trade to be the same as load following.

A. Correct. And we may get into the differences later on, but in some cases you are talking of load following, where you exactly follow the system load on a sort of minute by minute basis. We also use the term manoeuvres for where we are doing it over a longer period of time.

But essentially, I think we could take both these to mean much the same type of thing.

Q. So that if we looked at the capacity records of those two units that you have referred to, we would be mislead if we just used the annual capacity factor because it might have had a larger capability which wasn't realized because of load following or manoeuvring?

A. That's correct, and for those reasons we track both capability factor and capacity factor. And the differences are generally small for us but there was a period of time at Bruce where, I think I mentioned in my direct evidence earlier this week, the

capability factor was up to 8 per cent higher than the capacity factor during the period of locked-in energy at Bruce.

Q. If we look at page G-1 of Exhibit 526, we can see according to this document that as of June 1990 the generators that had the best performance are listed there, and included in No. 9 position, Point Lepreau, which is a CANDU 6 unit in New Brunswick; is that correct, Mr. Penn?

MR. PENN: A. Yes, it is.

Q. And in No. 10 spot, Embalse in Argentina which is also a CANDU 6 unit?

A. Yes, it is.

Q. And in No. 14 spot, Bruce 7, which is one of your units, and Bruce 5 in No. 17 spot?

A. Yes.

Q. And if we look over to page G-2.

A. One thing that I should comment on here, and I am not sure about this, Mr. Chairman, but a number of these units, particularly K-Kariwa in Japan and Tsuruga 2, I don't think have been operated too long.

Q. Exactly. They are units that have just come on, if we look at other charts; that's your understanding?

A. Yes.

Q. If you look at Table 2, page G-2, we seal that on a lifetime basis Point Lepreau is at the top of the list?

A. Yes.

Q. And Point Lepreau has been one of the - if not the - outstanding reactor in the world in terms of capacity factors, historically; is that a fair statement?

A. It has performed very well.

Q. And we can see the other units which are CANDU design: No. 4, Bruce 5; No. 9, Bruce 7; Nos. 12 and 13, Pickering 8 and Bruce 7; No. 15, Pickering 6, and No. 17, Bruce of 6.

So that the CANDU reactors have been occupying a very high rank in terms of capacity factors in the World Olympic Games of nuclear reactors?

A. Yes.

Q. Those are reactors over 150 megawatts electricity, we can see that at the top of table 2.

If we look at the units having over 500 megawatts electricity, again excluding some of the eastern European countries, we can see that out of the top 12 reactors listed, seven of them are CANDU reactors: Point Lepreau at the top; Bruce 5 at No. 3;

6, 7, 8 being Pickering 7, Pickering 8, Bruce 7; Pickering 6 at No. 10 and Bruce 6 at No. 12.

That's what that chart shows. That would be reflective of your understanding?

A. CANDU lifetime performance is good, and as Mr. Daly mentioned in his evidence in chief, the "B" stations on Ontario Hydro's system have excellent performance.

Q. Yes. And if we looked to table 4 and 5 on page G-4, of Exhibit 526, we can see the kind of statistics that you have reflected in your Exhibit 519 showing, particularly in table 5 when we look to lifetime factors, that the PHWRs, the CANDU units are the top ranked design in the world in terms of lifetime capacity factors.

A. I believe that's consistent with Mr. Daly's evidence. I don't know whether the numbers are exactly the same as ours.

MR. DALY: A. The numbers won't be exactly the same because this is on a year ending June 30th basis and all our figures were on an annual basis, but they are generally consistent.

Q. I want to look to what I seem to be able to find as the most recent analysis of this. I have a handout, if Ms. Findlay can assist.

THE CHAIRMAN: Give that an Exhibit No, Mr. Heintzman?

MR. HEINTZMAN: Yes, please, Mr. Chairman.

THE CHAIRMAN: 527, will it be?

THE REGISTRAR: 527, Mr. Chairman.

---EXHIBIT NO. 527: Excerpt, Nuclear Engineering International, February 1992, Load factors to end Sept 1991.

MR. HEINTZMAN: Q. You will see, Mr. Penn and Mr. Daly particularly, that this is from February 1992, Nuclear Engineering International. Is that a recognized publication concerning this subject matter?

MR. PENN: A. Yes. It regularly reports on this matter.

Q. Perhaps we can first look to the second page, and just dealing with the annual figures, up to September 1991, the first is Point Lepreau, the second is Pickering 8, the third is Pickering 6, and the fourth is Bruce 6.

First, the four top units in the world according to this journal were CANDU units. Would that be a fair statement?

A. I believe it is, yes.

Q. And if we then go down to position

nine, Pickering 7. So that of the top nine, five of them were Canadian CANDU reactors?

A. Yes.

Q. And if we go down to position 18, Wolsong 1 is the CANDU reactor or the CANDU station in Korea; is that correct?

A. That's correct, yes.

Q. And then at position 20, Bruce 8, and then if we go down to position 26, Gentilly 2, that is a CANDU 6 reactor station in the Province of Quebec.

[12:25 p.m.]

A. Correct.

Q. Position 36 Embalse in Argentina, again a CANDU 6 station; is that correct?

A. Yes.

Q. And you may just want to note these others, members of the panel and the Board. At position 58, Bruce 3; and if you go on to the right-hand column Bruce 5 at the position 100; Bruce 4 at position 101; Pickering 5 at 108; Pickering 2 at 117; Bruce 7 at position 140.

And going onto the next page, position 218, Bruce 2; position 243, Pickering 1; position 297 on the right-hand column Pickering 4; and then position 335, Bruce 1; 339, Darlington 2; and 343, Pickering 3.

And some of those latter units are either in their start-up phase or in a retubing mode. Would that be correct?

A. Pickering 3 would be about to return to -- after retubing. I don't recall as of September 1991, I don't know whether Mr. Daly can help me on whether Pickering Unit 4 was shut down for retubing or not.

MR. DALY: A. Pickering Unit 3 completed retubing in August of '91 and the same month Unit 4 was taken down for retubing.

Q. And Bruce 1 is shown at load factor of 22.7. What was its situation?

A. Bruce 1 has experienced steam generator tube leaks and has been shut down for periods of time to repair those leaks.

Q. Just while I am on that subject. Apropos of a question asked by Dr. Connell concerning the rotors at Darlington, transferring it to the steam generators at Bruce, would I be correct that that is a steam generation problem that could occur in any kind of a unit whether nuclear or fossil?

MR. PENN: A. The nature of problems with steam generators depends upon its design. It depends upon the chemistry control of the feed water.

And of course it would depend upon the age of the steam generators. And so those issues that I have elaborated on are common issues with steam generators at large. We have actually had good experience until fairly recent times with our steam generators.

MR. DALY: A. I have really nothing to add. I am not familiar with fossil steam generators.

Q. And by your answer, Mr. Penn, do I understand that those factors could more or less apply to a fossil generation station as to a nuclear generation station depending on the design criteria of either?

MR. PENN: A. They certainly might. This is not an area on which I have expertise. So I really can't help you further, Mr. Heintzman.

Q. Right. If we look at that third page of Exhibit 527, you will see the tracking of performance which you have basically lifted or put into your Exhibit 519 on one of the pages of your exhibit, as I understand it.

MR. DALY: A. Not completely. I believe this is reactor is over 150 megawatts, and the exhibit that we provided was for reactors over 500 megawatts only. Also these statistics are to the end of September, a year to the end of September. Our

statistics were to the end of the year. So there are some differences.

Q. But basically tracking the same kind of thing.

A. In general they are the same, yes.

Q. If we go back to the first page of Exhibit 527, we see the country averages to the end of September 1991 and Canada at 72.8 annual load factor and 74.8 lifetime load factor. This is coming from this journal. I take it you would accept that number as being a fair number?

A. I haven't any reason to doubt them. They are certainly in the right ballpark.

Q. And we can see up in the top right-hand corner again the kind of comparison of the PWRs, BWRs and PHWRs being the CANDU reactors that, particularly in the bottom chart, show that the PHWRs on a cumulative load factor are significantly above the PWRs and BWRs?

A. I think those figures are generally similar to the figures I presented, yes.

Q. And down on the bottom right-hand corner again the top ten performers for lifetime load shows that the top four are as we have seen Point Lepreau -- sorry, then we have one from Germany and

then Pickering 7 and Bruce 5.

MR. PENN: A. That's correct, yes.

MR. DALY: A. Correct.

Q. And then Pickering 8 as the ninth unit.

For the assistance of the Board, Mr. Penn, I would like to, if I could, try to ensure that the Board understands the difference between a CANDU reactor and a PWR and a BWR, and I have prepared a document which says it in my language and therefore I would ask you to help me through it so the Board understands the difference between a CANDU reactor and a PWR and a BWR and I have would ask Ms. Findlay to distribute this document.

THE CHAIRMAN: I suppose we should give this document an exhibit number.

MR. HEINTZMAN: If it could, yes.

THE REGISTRAR: No. 528.

---EXHIBIT NO. 528: Document entitled Comparison of CANDU Reactor, Pressurized Water Reactor (PWR) and Boiling Water Reactor (BWR).

MR. HEINTZMAN: Q. You will see what I have here are two pages of verbal description and then three diagrams to help us understand them and then three pictures of various aspects of the CANDU reactor to help us through the exercise.

If we can look at the third page, and you have covered this in description in your evidence in chief, Mr. Penn, so I don't want to go over it more than I have to just to bring out the differences.

So what I have attempted to show or what I have got picture of on the third page of Exhibit 528 is a CANDU reactor; and by looking at it, you can see that it is similar to what we have in the DSP or indeed in your Exhibit 519?

MR. PENN: A. It is my view that this design is typical of the CANDU 6 design.

Q. Yes.

A. Where the steam generators and reactor of course are all within the pressurized containment.

Q. Yes. So perhaps we can just compare it to your --

A. My colleague Mr. King has just pointed out to me that this is a Pickering design because its shows, Mr. Chairman, the dump tank that Mr. King referred to for shut-down purposes in his evidence on safety. So it's of the Pickering CANDU 6 variety.

Q. So if we can follow the language on the first page, as you have told us, and if I could just read it and you can correct me if I am wrong, so

that we can then compare it to the PWRs and the BWRs.

Looking at the diagram, you will see the little "f" with the arrow on it. In the CANDU reactors, we have "Horizontal pressure tubes..." is that correct?

A. Yes.

Q. And continuing. "...in the reactor core contain short natural uranium fuel bundles...." which we have one in exhibit.

"Heavy water coolant flows through the pressure tubes, and the nuclear fission in the bundles heats the heavy water coolant. The pressure tubes are inside calandria tubes which are in turn surrounded by the heavy water moderator which is contained in a tank-like structure ('the calandria'). The whole assemblage of tubes and tanks is the 'reactor core'."

I think calandria has one L and not two.

A. I was about to correct you.

Q. The fission is controlled by control rods (C), which you will see shown in the diagram going down through the reactor core. The heated heavy water in the pressure tubes travels under pressure to: and

you will see up to the steam generators marked with A on each side. Is that a fair description of the CANDU reactor?

A. Yes, I think it parallels my description of it in my introductory evidence.

Q. Yes. And I have included this description under the heading "Primary Circuit" because as I understand it, the CANDU reactor has a primary circuit and a secondary circuit which is a similar feature to the PWR and distinguishes those two from the boiling water reactor?

A. That's correct.

Q. And the heated heavy water in the primary circuit then goes to A, the steam generator, where the heated heavy water transfers its heat to the light water in the secondary circuit, and we can see that that passes off out of the top of the steam generator as steam.

A. That's correct.

Q. I haven't included here the remaining portion of the technology which is on your exhibit which would be common to the other reactors.

A. That's correct.

Q. And then we see --

A. Well, the other light water reactors

anyway.

Q. The other light water reactors, right.

And then we can see the heavy water at the bottom of the steam generators passing back through pumps B back into the reactor core?

A. Yes.

Q. And if you look at the last two pages taken from Exhibit 185, Dr. Hare's report, we can see -- and I think the members of the Board have been to see the face of the reactor core showing the pressure tubes to which I have referred.

A. I'm sorry, were you asking a question?

Q. We can see the pressure tubes on the faces of the reactors.

A. Yes, I can see it on the last but one page, figure 1-7(a). And with the feeders coming off the end of them which would then go to the headers that I mentioned in my evidence.

Q. Yes. And then the secondary circuit -- and this was prepared before your evidence so it is somewhat duplicative, but I want to make sure we understand what we are doing before we come to the PWRs and BWRs. The secondary circuit has the light

water being converted into steam as we have discussed?

A. Correct.

Q. And the reactor is contained in the building D which in the CANDU 6 is a fortified structure if I can call it that; whereas in the Ontario Hydro designs, it's of a less fortified structure and uses a vacuum building technique to deal with build-ups of pressure within the reactor building.

A. Well, they are both fortified structures. This design is a pressurized containment whereas the containments in Hydro plants in existence today have negative pressure, but are capable, of course, of high pressure in the event of an accident.

Q. But the real distinction between the CANDU units that Ontario Hydro has built and a CANDU 6 is really that feature, the structure of the building as opposed to using a vacuum system?

A. Correct.

Q. Otherwise the CANDU 6 technology and the Ontario Hydro reactor are to all purposes the same or practically similar?

A. They are very similar, yes.

Q. And then I have noted at the bottom of page one, the two shut-down systems that you mention in your evidence which exist in the Ontario Hydro units

other than I believe some of the earlier Pickering units?

A. Pickering "A" units do not have liquid neutron absorber injection; they have dump tanks.

Q. Now what I would like to do is compare that not in undue length to the pressurized water reactor. And the distinguishing feature of the pressurized water reactor, as I understand, is that there is a pressure vessel inside the reactor building, which is a single thick-walled vessel, as opposed to using tubes in the CANDU system, which contains a reactor core and contains the fuel rods.

The fission occurs in enriched uranium fuel rods as opposed to the CANDU units where they are of natural uranium; that the fuel rods are many feet long, as I understand it, in the PWR; and the fission in the fuel rods heats the coolant which is light water in the pressurized water reactor. Am I correct so far, to your understanding?

A. You are largely correct.

Q. Please correct me --

A. They are really fuel assemblers because as you mentioned here they are very long. They are the full length of the reactor as opposed to 24

inches long.

Q. So you would use the word "assemblages" rather than rods?

A. Assemblies.

Q. Assemblies, yes.

A. Fuel assemblies.

Q. Yes. And it heats the light water. And in this case in the PWR because we are inside a single pressure vessel, the next sentence says that the light water acts both as a coolant and as moderator.

A. That's correct.

Q. So that the coolant and moderator are in the same vessel whereas in the CANDU the coolant is in the pressure tubes and the moderator is in the calandria vessel?

A. Correct.

Q. And separated.

A. In a pressurized water reactor the coolant and moderator are one and the same thing.

Q. Right. And the rate of fission is controlled by the control rods which would be a common feature to all three of the units that we will be looking at?

A. Yes, it would. PWR assemblers and PWR fuel assemblers also have cruciform control rods

within them.

Q. Yes.

A. Whereas the fuel in CANDU does not have control rods within the fuel. They are separated.

Q. Right. So that's a distinction that I have not noted here but you have drawn to our attention.

And then I continue. The hot pressurized water then travels to the steam generator, as shown in A on the third page of Exhibit 528, so that feature is the same as the CANDU; namely, the flowing of the coolant from the reactor process to a steam generator? [12:45 p.m.]

A. The principle is the same in that regard.

Q. And the steam generating process is similar to the CANDU process, and there is a secondary circuit of light water as in the CANDU process?

A. Yes. The piping arrangement is different but the principle is the same.

Q. So, as we look at the bottom of the third page, we have the primary circuit revolving out of the pressurized vessel into the steam generator in the same fashion as we do in the CANDU reactor on the top of the page, circulating back between the reactor

core and the steam generator?

A. In principle we do. Of course in a CANDU reactor we have feeders from each of the horizontal channels and in this concept we have the main primary heat transport piping from a particular location in the reactor vessel as shown on the diagram.

Q. Yes. In the PWR I have noted under paragraph 2 that there is a single shutdown system using shutdown rods; is that correct?

A. The pressurized water reactor system has a single shutdown system which is assisted by a boron injection system once that shutdown system has operated.

Q. Unlike the CANDU which has separately operated shutdown systems as described on the first page?

A. Correct. The pressurized water reactor does not have independent separate shutdown systems except for the United Kingdom Sizewell B design.

Q. And to that extent, the PWR shutdown system is more akin to the Pickering "A" units which have the single system?

A. In principle, yes, but not in physical characteristics.

Q. Yes. And then finally, the BWR, which is shown on the fourth page, and here we have a pressure vessel containing light water and the reactor core in the centre of the reactor. The principle here is to convert the light water directly into steam so that one does not go through both a primary and secondary circuit?

A. Correct.

Q. And that we can see in the diagram occurring by the steam coming off the top of the reactor and passing out through the right-hand side of the top of the reactor?

A. That's why it's called a boiling water reactor in a single vessel without steam generator.

Q. So the water is boiled right in the vessel itself?

A. Yes.

Q. Now, with that background, I would like to have you comment upon the following advantages of the CANDU system.

First of all, one of the major advantages of the CANDU system is that you don't have to shut down the unit in order to refuel, you can refuel it on-power?

A. We believe that's an advantage, yes.

Q. And. Whereas in the PWR and the BWR, because the fuel is in the vessel in the centre of the reactor, you have to stop the reactor in order to take out the fuel and put in new fuel?

A. Yes, you do. But I think we should qualify this by saying that in the past that process of refueling was a critical path issue in the capacity factor of light water reactors.

However, in the evolutionary designs that I described yesterday, where new fuel assemblies with much higher burn ups have been designed, it is no longer a critical path issue in the annual outage of maintaining light water reactors.

So the advantage therefore that CANDUs had is now reduced somewhat.

Q. By that do you mean the speed with which one can take the used fuel out of a PWR or BWR and replace it is diminishing, or you can do it faster?

A. It's not necessarily the speed. It's the time between the periods when it is necessary to shut down light water reactors in order to refuel. Now they have longer burn up and the time is longer inbetween refueling.

Q. So that the advantage of CANDU, its

continuous operation is diminishing because of the longer times that you can have the fuel in the PWR or BWR; is that what you are saying?

A. Well, it's a move in that direction. As yet these evolutionary plants are not in operation, so we don't have the benefit of their performance, but in theory it's my judgment that the refueling of light water reactors is not on the critical path to the extent it used to be.

Q. And is it fair to say that the development of light water reactors and other reactors is going through a considerable development process at this very time?

A. It's true to say that there are considerable efforts in the world to simplify the designs, to improve their safety and particularly reduce the period of construction, just in the same way that Ontario Hydro spent considerable effort in studying methods to reduce the schedule and costs of its plants as well. There has been that move for quite a number of years.

Q. Now, the second advantage of the CANDU system, I think we have already commented on that, is the fact that the units other the Pickering units have a dual shutdown mechanism.

Would you consider that to be an advantage?

A. Yes.

Q. The third advantage as I understand it is the fact that the CANDU reactor uses natural uranium, and I understand that an enrichment plant -- if you are going to have enriched uranium which you need, as I understand it, for a PWR or BWR; am I correct?

A. You need a method of enriching uranium, yes.

Q. And that the construction of an enrichment plant is a very expensive proposition, whereas the construction of a plant to produce heavy water is a much less expensive and a simpler technology.

A. I believe you are right, but I don't have in my mind the capital cost of a centrifuge or diffusion plant as opposed to a heavy water plant.

It's certainly true that the cost of diffusion plants is very much higher, but I am not certain about centrifuge.

Q. I don't think we have to turn it up right now, but I noted in Dr. Hare's report, Exhibit 185, and I will give you the reference, I-103, it is

stated: Heavy water separation technology is however simpler than the technology of uranium enrichment, as being one of the reasons why going this route rather than the enriched uranium route is an advantage for a country such as Canada. That's I-103 of Exhibit 185.

A. While I would agree with that statement, I was trying to comment on the cost of building a heavy water plant and an enrichment plant which is what I thought you were asking.

Q. I was.

A. Of course they depend upon the size and production capacity and all the rest of it.

Q. It's my understanding that most countries in the world that have PWRs or BWRs purchase their enriched uranium from one of a very few countries that have uranium enrichment plants; is that correct?

A. That's correct. There are about five countries that have enrichment plants.

Q. So that if Canada was to purchase enriched uranium, it would have to, unless it were to build its own enrichment plant, purchase that from such a country?

A. Yes.

Q. Whereas by using a CANDU reactor you have the ability at lesser expense, I understand, but

certainly now we have such technology here in Canada to purchase the heavy water from our own indigenous source?

A. Yes. The whole reason why Canada adopted the natural uranium heavy water system had to the indigenous resources of Canada with uranium and of course of the technology developed in the 1940s where Canada concentrated on this type of technology.

Q. So you would consider that to be an advantage, the fact that we can use natural uranium which we have here in abundance and heavy water?

A. I think it is a natural evolution which has been beneficial to this country.

DR. CONNELL: Mr. Heintzman, could I just ask.

I understand it's also true that CANDU can be adapted to a Thorium fuel cycle; is that correct?

MR. PENN: Yes, it can be adapted to a very large number of different fuel cycles, and that we at Hydro -- in fact, I led a section that reviewed slightly enriched uranium. It looked at mixed oxide, that is the combination of plutonium and uranium oxide; it looked at the mixed oxides of Thorium and plutonium and Thorium and uranium.

And yes, it's quite true that the CANDU reactor could operate on any of those cycles. But it's also true that given the cost of uranium, and this has always been the case, that it is much cheaper to use the natural uranium cycle than any other. And in fact, the next cheapest is the slightly enriched uranium cycle. If the spot price of uranium had exceeded $30 U.S. a pound, then we may have adopted it.

But the price of uranium has actually dropped in the last 10 years to between $5 and $10 a pound of U308.

DR. CONNELL: Thank you.

MR. HEINTZMAN: Q. And a fourth factor which I understand is considered to be an advantage is that because of the design of a CANDU and the existence of the coolant in the moderator, in the large containment that it is, and the systems built into it, that the probability of what is known as a melt down occurring is very improbable; would that be a fair statement?

MR. PENN: A. There is much reduced risk, and I would like to invite Mr. King, if he would like to comment a little further on that matter.

Q. Well, I have a document written by Mr. King that I was going to ask him to comment or to

identify. Perhaps that can be handed out.

A paper entitled CANDU Safety Under Severe Accidents: An Overview, you are one of the co-authors of this paper are you, sir?

MR. KING: Yes, I am.

MR. HEINTZMAN: If that could be marked as the next exhibit.

THE REGISTRAR: No. 529.

---EXHIBIT NO. 529: CANDU Safety Under Severe Accidents: An Overview.

MS. HARVIE: Mr. Chairman, I would like to bring to your attention and that of counsel for AECL that it has been past practice in this hearing to provide the proponent and other parties with documents that are going to be put to the witnesses previous to their cross-examination. It is just a matter of courtesy and it certainly may even assist your cross-examination if the witnesses have had an opportunity to familiarize themselves with the materials beforehand.

MR. HEINTZMAN: Certainly if my friend would like to know what documents I intend to refer to, I would be delighted to help her out.

MS. HARVIE: Thank you. Perhaps you can distribute those over the lunch hour.

MR. HEINTZMAN: Certainly.

THE CHAIRMAN: Perhaps then we can take the lunch break at this time and we will be back at 2:30.

THE REGISTRAR: Please come to order. This hearing will adjourn until 2:30.

---Luncheon recess at 1:00 p.m.

---On resuming at 2:35 p.m.

THE REGISTRAR: Please come to order. This hearing is again in session.

MR. GREENSPOON: Mr. Chairman, I have just filed with the Registrar a document entitled Environmental Impacts of Elliot Lake Mill Tailings. If that could be given a number.

THE CHAIRMAN: Will you give that an exhibit number, please.

THE REGISTRAR: 530.

---EXHIBIT NO. 530: Document entitled Environmental Impacts of Elliot Lake Mill Tailings.

THE CHAIRMAN: Mr. Heintzman.

MR. HEINTZMAN: Thank you, Mr. Chairman.

Q. Mr. King, we were just about to look at Exhibit 529. Is that a paper which you co-authored?

MR. KING: A. Yes, I was one of the authors.

Q. And it addresses the issue of CANDU safety under severe accidents?

A. Yes.

Q. And as I understand the thrust of the report, it is addressing the issue of what core damage might occur if there was a severe incident in a CANDU reactor?

A. That's generally correct, yes.

Q. And you say at the bottom of page 122 where you start this paper:

> "A severe accident is defined as one in which the fuel heat is not removed by the coolant in the primary heat transport system. In most other reactor designs, this is equivalent to a core melt, and indeed severe core damage (defined as loss of core structural integrity) is one end of the spectrum in CANDU. However, the inherent characteristics of CANDU provide a broad spectrum of scenarios where even if primary and emergency cooling are lost, the fuel does not melt. This results both from inherent design characteristics and the Canadian licensing approach."

That's the thrust of the article?

A. Well, this paragraph you just read is accurate.

Q. Right. And in the abstract at the beginning, just so we don't have to review the report in more detail than is necessary, as I understand what is being said here, starting in the second sentence that there is about four factors that lead to this result. Starting with the second sentence, you say or the abstract paraphrases you as saying the pressure tube concept allows the separate low pressure heavy water moderator to act as a back-up heat sink even if there is no water in the fuel channel.

So that's, I take it, one of the points that the presentation makes?

A. Yes.

Q. And then the next point:

"Should this also fail, the calandria shell itself can contain the debris, with heat being transferred to the water-filled shield tank around the core."

That's the second point that is drawn out of this paper in the abstract?

A. Yes. We are now into an area of,

from a CANDU point of view, a non-design basis accident.

THE CHAIRMAN: A non...?

MR. KING: A non-design basis accident.

Because they have assumed here that the moderator as a heat sink has also failed.

MR. HEINTZMAN: Q. So the next stage is what happens then. And this is summarizing your conclusions as being that the calandria shell itself can contain the debris with heat being transferred to the water filled shield tank around the core?

MR. KING: A. The paper refers to some analyses performed at AECL and by Professor Rogers at Carleton University which contained analysis to that effect. The AECL analysis was to do with the CANDU 6 reactor.

Q. Then the third point drawn from your report is:

> "Should the severe core damage sequence progress further, the shield tank and the concrete reactor vault significantly delay the challenge to containment."

Is that a correct derivation?

A. That's a further summary of the

analysis I had just referred to.

Q. And then the fourth point"

"Furthermore, should core melt lead to containment overpressure, the containment behaviour is such that leaks through the concrete containment wall reduce the possibility of catastrophic structural failure."

A. I believe what is being referred to here, which the paper discusses in more detail, is some work done at the University of Alberta which shows that concrete containments, if you over-pressurize them, will tend to crack and leak rather than fail in a catastrophic manner.

Q. And then there are various references to licensing criteria and probabilistic safety assessments. I take it those safety assessments would include -- well, it refers to them, the ones being done in the Darlington station. Those would be assessments that you or your department was involved in?

A. The one on the Darlington station, yes.

Q. And the article then concludes, without going through it in detail, or the paper on page 145 with the inherent characteristics of the CANDU

reactor which leads to the conclusion that you refer to at the beginning of the article; is that correct?

A. You are referring to the first three dashed points here or...

Q. Yes. And generally the conclusions in paragraph 7 are the conclusions that can be looked to in support or in the result of what you described at the beginning of your article as to why the CANDU is or has a design proclivity against meltdown and the other problems addressed in the paper?

A. Yes. Well, the conclusion of the paper is a summary of the paper.

Q. Yes. And would you describe these as advantages of the CANDU system?

A. With respect to the accident scenario loss of coolant accident and a loss of the emergency coolant injection system, having a moderator in the configuration that it is in a CANDU is an advantage.

Q. And Mr. Penn, if we could just go back to Exhibit 528, which is my little comparison of the BWR. And BWR, there is one diagram that I didn't look at and that was the fueling machine on the third last page.

And I am sure everybody understands how this works but I would just like to have it described

for the record. As I understand it, this machine which we see there represented can inject the fuel bundles into the face of the reactor through the nozzle and from the revolving apparatus at the back of it.

MR. PENN: A. Yes, that's basically correct. You can see the fueling machine suspended from the bridge which allows traversing the reactor core to visit each channel pressure tube with the fueling machine.

Q. So by going sideways or up or down you can reach each and every pressure tube?

A. Yes.

Q. And as I understand it another advantage of the machine is that you can have one on the other end to take fuel out at the same time fuel is being put in, so you can have one machine on one end and one machine on the other end?

A. That's correct.

Q. Now I have handed to you a report, and I trust that the Panel members have a copy of it, issued by an organization entitled UNIPEDE which I understand to stand for the Union Internationale des Producteurs et Distributeurs d'Energie Electrique or, in English, the International Union of Producers and Distributors of Electrical Energy.

May this be marked as an exhibit, Mr. Chairman?

THE REGISTRAR: That would be number 531 Mr. Chairman.

THE CHAIRMAN: Thank you.

---EXHIBIT NO. 531: Document produced by UNIPEDE entitled Electricity generating cost. Evaluation made in 1990 for plant to be commissioned in 2000.

MR. HEINTZMAN: Q. You will see from the bottom of the first page that one of the participants in this group of experts that prepared this study entitled Electricity generating cost. Evaluation made in 1990 for plant to be commissioned in 2000 was Mr. Meehan of Ontario Hydro.

I guess I should ask you, Mr. Penn. Are you familiar with this report?

MR. PENN: A. I am not quite sure. I visited with Georges Moynet who is the primary author and chairman of UNIPEDE in January of this year and I did discuss this sort of subject with him, but I am not sure since I haven't had a chance to read it totally. But I am familiar with the subject.

Q. What I would like to do is review it with you and after you have had a chance to look at it over the weekend if you have anything further to add, I

would like to do that on Monday.

A. I would be pleased to do that.

THE CHAIRMAN: Let's confirm one thing. Do you confirm that Mr. Meehan is one of the authors of this report?

A. Yes, I do, sir.

Q. And Mr. Meehan is the same Mr. Meehan who was a member of the Fossil Panel in this hearing; is that correct?

[2:45 p.m.]

A. Correct, yes.

Q. And he was scheduled to be one of the persons on this panel, was he not?

A. Well, at one time his name was brought up for consideration, but I don't think I would describe it as scheduled.

Q. We received a witness statement indicating that he was going to be one of the members this panel.

A. Fine.

Q. That was enough scheduling for my purposes, anyway.

And Mr. Moynet is the same Georges Moynet who was one of the participants in the Ontario Nuclear Cost Inquiry?

A. Yes, he is.

Q. And he is an employee of Electricite du France?

A. Yes.

Q. And this is, so far as I have been able to find, one of the most recent, if not the most recent authoritative study of the comparative cost of generating electricity including nuclear generation?

A. Yes. UNIPEDE is a well-known world organization, charged with this work.

Q. And Ontario Hydro is a member of UNIPEDE, is it not?

A. I am not sure that we are an official member or an invited member. But Ontario Hydro does provide information to UNIPEDE and has done so for a number of years.

Q. As I understand it, UNIPEDE originated as European organization studying the sort of matters that we see in this paper?

A. Yes, as part of the OECD community group.

Q. And the individuals who participated in this study, I don't know whether you can confirm, but certainly Mr. Moynet would be a renowned authority on the sort after matters addressed in this report,

would he not?

A. Georges Moynet has been chairman of the group, in my knowledge, for ten years.

Q. And if we turn to - I think the document can be to some extent taken as read - but if we look to the abstract, and just reading the first two paragraphs and the first sentence of the third paragraph:

> This paper gives the main results of the work carried out in 1990 for calculating the generation costs of base load electricity from nuclear power stations and fossil fueled thermal power stations expected to be commissioned at the end of the century. Calculations were carried out by a method developed by this group which is now in common use and employee a maximum number of common assumptions, including scenarios for fuel prices so as to obtain valid comparison between countries.
>
> The main conclusions are as follows: Nuclear stations which are constructed in a well developed and adequate industrial scenario are expected to be the most

competitive compared with coal-fired stations and natural gas-fired combined-cycle stations for base load generations.

In countries where nuclear --

That's the second sentence. Stopping right there.

That is the conclusion of this report, that for base load nuclear stations are expected to be the most competitive.

A. I think I would have to qualify it by saying most competitive within the major industrial countries in Europe. I'm not sure that United States is a members of UNIPEDE, but certainly the major countries in Europe are represented.

Q. And Canada?

A. And Canada.

Q. And if we turn then to page, I think we can take the --

A. I might say Japan also. I forgot, Japan is also in there.

Q. If we turn to page 6 under heading 3.1, Nuclear Plant, the documents says:

This is plant of the PWR, BWR or CANDU type with differences arising in

the unit size (from 900 to 1,400 megawatts) and in the site conditions (one or more units per site cooling arrangements). It should be noted that all countries included a provision for decommissioning of nuclear plant in their capital costs. In addition, nuclear fuel cycle costs for all countries include all costs associated with both the front end and the back end of the nuclear fuel cycle.

And then if you would turn with me to page 9, the first figure sets out the investment costs of the nuclear stations, coal stations and natural gas stations shown therein, and you will notice the figure for Canada in each case is a relatively low - except for natural gas - number. Would you agree with my statement to that effect?

A. That's what the diagram shows.

Q. And would you be able to confirm from Mr. Meehan that he provided the input into this report and that he was satisfied with the report and its conclusions?

A. I can certainly consult with him, yes.

Q. Thank you.

I don't know if that needs an undertaking number or I can just take it as such.

THE CHAIRMAN: It's up to you.

MR. HEINTZMAN: I am content to have it given in due course.

THE REGISTRAR: Do we need a number?

THE CHAIRMAN: All right.

THE REGISTRAR: 532.

THE CHAIRMAN: 532 will be the undertaking number then.

---UNDERTAKING NO. 532.1: Ontario Hydro undertakes to confirm from Mr. Meehan that he provided the input the report and that he was satisfied with the report and its conclusions.

MR. HEINTZMAN: Yes.

Q. If we turn then to figure 2 on page 11. This figure gives us generating costs now including the investment costs in black, the operating and maintenance costs in white, and fuel costs in gray. And again, we can see that for nuclear and coal stations, Canada ranks in the case of nuclear the lowest, and in the case of coal stations lowest but one to the Netherlands. That's what this chart would show.

MR. PENN: A. Correct. If I may point out --

THE CHAIRMAN: I'm sorry, am I looking at the right page? I am on page 9. Is that the right page? Page 11?

MR. HEINTZMAN: I think we went past figure 1.

THE CHAIRMAN: I'm sorry, all right.

MR. HEINTZMAN: We looked at figure 1, Mr. Chairman. Now we are on figure 2. Figure 1 shows the just the investment cost, figure 2 shows investment O&M and fuel.

THE CHAIRMAN: Okay. Thank you.

MR. PENN: I might add, Mr. Chairman, perhaps it might be helpful, that in UNIPEDE the word investment cost is synonymous and the same with what I spoke of as capital cost. And the word generation cost is the same, and the units here in European community units per kilowatthour is the equivalent of levelized unit energy cost in cents per kilowatthour with due conversion for currency, of course.

MR. HEINTZMAN: Q. Yes, if we look at figure 2, we can see looking down at the bottom, No. 2 for European community units per kilowatthour and run our eyes up, we can see that Canada is 2.4, 2.5 ECU per kilowatthour for nuclear.

A. Correct. And this data, in my

knowledge is for the 4 by 881 megawatt station.

Q. Yes. Well, perhaps we can look to page -- at back you will find all of the information giving the assumptions and perhaps we can look to Appendix 2 on the points, the two points you have just raised.

The bottom of the appendix D, the main assumptions, we can look at all sorts of assumptions on that page, but at the bottom for currency exchange if you want to convert these moneys into Canadian dollars it's 1.373, we would multiply by to get Canadian dollars, as I understand it.

A. That's correct.

Q. And on the next page, technical description under Canada you will see exactly what you said, CANDU 881 lake site, four units, et cetera.

A. Lake direct referring to cooling water intake.

Q. Right. But the kind of unit that you just referred to is there described.

A. Yes.

Q. And then if we can go back to figure 2, the numbers shown there as you described, the LUEC for nuclear stations in ECU currency and then in coal and then in natural gas.

A. Yes.

Q. Right. And we can say that the LUEC given by this study for Canada is somewhat over 3 ECU per kilowatthour.

A. Maybe I am not on the right figure. Figure 2, page 11?

Q. Yes.

A. Total generation cost according to my view is about 2.4 European community units per kilowatthour.

Q. For nuclear?

A. For nuclear, yes.

Q. For coal station it is just over 3.

A. That's what it shows, yes.

Q. And for natural gas stations for Canada it's about between 4 and 5, or 4.5.

A. That's what it shows, yes.

As I say, I did go over this sort of information with Georges Moynet recently, but this figure is very much a function of the assumed capacity factor. Without reading the paper, I don't know what that is.

Q. I think they use a common capacity factor, and we can go over that after you have had a chance to look at it.

If you if to page 12, the authors say, about the middle of the page:

> General comments can be drawn that you are referring to base load generation. Nuclear generation is largely competitive compared to coal generation with a five per cent discount rate whatever the coal price scenario and remains competitive at 8 per cent. The only exception is from Spain when comparing nuclear and imported coal generation. With the 5 per cent rate, nuclear generation is largely competitive compared to natural gas generation, whatever the gas price may be. With 8 per cent nuclear remains largely competitive for the high and median gas price scenarios and in a few cases for the low scenario.

That, you will agree, would flow from the diagrams shown in the report?

A. I am generally aware that that is the situation. The discount rates are quoted in two ranges because different European countries have different -- actual interest rates and that's the purpose of them.

Q. Yes. I think the authors expand on

this on figure 3, where a 5 per cent discount rate is used, and if you look up the page from the No. 1, and come up to Canada, No. 1 would indicate that when you are comparing coal to nuclear, if it's above 1, then coal costs more than nuclear; right?

A. Perhaps you will allow me to go to where it describes what figure 3 conveys again for a moment, please.

Q. Certainly.

A. I believe that it is the ratio of coal to nuclear, but I can't see it clearly defined there, unless you can help me where it's stated.

Q. As I understand these tables, that's how it works. If you are comparing coal to nuclear, if coal is more than one to nuclear, then coal is more expensive.

If you look to page 15, for instance, I think it tells us the numbers in graph form that we see in figure 3.

A. It's clear in the first column you mean?

Q. Coal to nuclear, Canada it's 1.27 over 30 years if you use a 5.5 per cent discount rate?

A. I can see that, yes. So the ratio is coal to nuclear, at least in that table anyway.

Q. Yes. And on a 25 years it's 1.24. So that coal costs 1.24 times nuclear?

A. For the particular scenarios analyzed here, yes.

Q. And then we have natural gas to nuclear and natural gas to coal, showing the cost relationship of each of these alternative forms of generation.

A. Yes. The costs, returning to the subject of the paper, these are for projected nuclear natural gas and coal-fired stations that could be assumed to be in-service in the year 2000.

[3:05 p.m.]

Q. Yes. And what these gentlemen were trying to do is project these costs so that people can make decisions in light of the most informed factual basis?

A. As I understand it, the UNIPEDE report is distributed to both developed and developing countries.

Q. I understand that this was presented at the Copenhagen conference in June of 1991 as stated on the first page.

A. Yes.

Q. So looking back at figure 3, we can

see that at the high, medium and low fossil fuel scenarios, seen at the bottom of the page, nuclear is always a less expensive generation alternative. Is always above one. In Canada I am looking at.

A. Well, I am not sure that without study I can affirm that suggestion. The legend at the bottom of the table suggests to me that the paper has assumed a high price coal scenario, a medium price coal scenario, and a low price coal scenario presumably for the lifetime of the plants.

And if I look at Canada, it suggests that -- I agree this table suggests that for all three scenarios the ratio is higher than one.

Q. Right. And that's a 5 per cent discount rate scenario. And on figure 4, page 14, the same is done for an 8 per cent discount rate, and the advantage of nuclear is somewhat less but still in favour of nuclear on a comparative cost basis under those three coal price scenarios?

A. That's correct.

I think in my introductory evidence I indicated that in the year 2002, if that was assumed, and comparing it with U.S. supplied coal, that the levelized unit energy cost would be between 10 and 15 per cent lower for nuclear.

Q. Well, I found some comfort in finding an organization that studies this from an international standpoint having analyzed it and come to that conclusion. And do you think that we can take comfort from this kind of analysis?

A. Well, it is one organization in the world that does this form of analysis and I have every reason to believe that the member countries are supplying information that is valid.

Q. And on page 17 we can read the conclusions starting in the fourth paragraph. It says:

> "The main conclusions of the study are as follows: Nuclear units are expected to be the most competitive for base load generation, under all the fossil price scenarios studied, provided that stations are built under adequate industrial conditions, i.e. standardized units, industrial programme of significant size, multi-unit plants."

And then secondly:

> "Nuclear plants without standardization, for which the generation costs are higher...."

And then certain conclusions:

"provide some economic advantage compared to coal-fired, the advantage becoming small if coal prices remains low in the long term."

And "are competitive with gas fired combined-cycle gas turbines only within the context of a high gas price scenario but lose their economic advantage if gas price is low or moderate, especially at higher discount rates."

And if we look back at the figures. And I think you made this point in chief, if you look back at figure 1, and perhaps it says graphic in figure 2, there is quite a difference between the cost if you look at figure 2 of generation in Belgium, Canada, and France, which are the three lowest generation cost producers, and Japan, the Federal Republic of Germany, United Kingdom and Spain. Would you agree with that?

A. On the basis of levelized unit energy cost, that has been the case for some years.

Q. And the lesson that this study is drawing or one of them besides comparing nuclear with fossil or natural gas is that standardization has a dramatic effect on keeping generation costs down in nuclear technology?

A. It's one of the most important characteristics.

Q. And to the extent that Ontario Hydro has been successful at standardization, it has realized substantially lower generation costs than other countries?

A. I am not sure that I would agree it is connected necessarily just with standardization. And of course our costs we have to admit have risen

Q. But to the extent that you have achieved standardization, these graphs show that that has paid off in terms of comparative generation costs looking at that one issue of standardization as opposed to non-standardization.

A. Well, the principle of standardization is important.

Q. Yes. And results in lower costs?

A. It has done, yes.

I think in all fairness I should point out that we have been looking at one of the characteristics of nuclear. There are, of course, other characteristics that have to be weighed.

Q. Such as?

A. Such as all the other features of operating the plant.

Q. Well, these charts try to capture all of the cost ramifications, whether they be investment, operating, maintenance or fuel, don't they? Are there any other cost implications that this study does not capture?

A. Well, I believe the cost model used is similar to the one I described but I don't, I haven't seen it in this paper so I can't confirm that.

Q. Well, this study was carried out in the discounted cash flow method using the LUEC principle which Mr. Moynet applied or used in the ONCI study; isn't that correct?

A. Mr. Moynet certainly was one of the commissioners that reviewed ONCI. All I was mentioning was that I am not sure what the cost model is here, not the method of levelizing the cost. I am talking about the model.

Q. I see. Well, would you.... I want to make certain --

A. This model here.

Q. I want to make certain that there are not some cost factors that are ignored by Mr. Meehan in the information that he transferred to the study or that the study considered. When you look at the study, can you see any that you would consider appropriate

that have been ignored?

A. Well, I will review it this weekend and I will let you know.

Q. Okay. And would you ask Mr. Meehan, if you have any doubts on that, whether he is satisfied that all of the cost elements were included and that he is satisfied with the authenticity and correctness of the data and the results of the study?

A. I will consult with him, yes.

Q. Thank you.

Now the next report that I would like to look at as being the other international study that I could find of recent origin is one by the Organization of Economic Co-operation and Development. And I believe I gave that to you over the lunch hour.

Mr. Chairman, I have an original copy of this report which I would be happy to leave with the Board. It's the only original that I have but you will make far better use of it than I will. And if I can leave it with you as either the exhibit or one of the documents that the Board has.

And the copy that I have handed out is not every page. And I have extra copies of the document if anybody wishes a copy of every page in the study. May this document entitled Projected Costs of

Generating Electricity from Power Stations for Commissioning in the Period 1995 to 2000 be marked as the next exhibit.

THE CHAIRMAN: Number?

THE REGISTRAR: That will be 533, Mr. Chairman.

---EXHIBIT NO. 533: Document entitled "Projected Costs of Generating Electricity from Power Stations for Commissioning in the Period 1995 to 2000".

THE CHAIRMAN: Now do I understand that this document you have filed is the original complete document but what we all have here is not the complete document? Is that right?

MR. HEINTZMAN: That's correct. And if you wish me to make -- I think we have extra copies. We will make extra copies for everybody to the extent that anybody wants one. But I am only going to be referring to these pages.

THE CHAIRMAN: Okay.

MR. HEINTZMAN: Q. And Mr. Penn, I only handed this to you over lunch time and I don't know if you have had a chance to look at. But are you familiar with this study?

MR. PENN: A. I haven't had a chance to glance at it. You gave us about six different

documents.

Q. I am going to give you everything I can tonight so you can have them all for the weekend.

A. Thank you.

Q. It will be a good weekend.

A. My wife will love it. [Laughter]

Q. Just like mine did last weekend.

A. I am familiar with the OECD NEA's organization, but I don't believe I have read this particular document.

Q. What I would like to do is refer you to the material portions. And again if on Monday you have any comment you wish to make, you will let me know I'm sure.

And OECD is an organization located in Paris of which Canada is a member?

A. Yes, that's correct.

Q. And it has a nuclear engineering energy agency as part of that organization, does it?

A. Yes, it does.

Q. And it particularly is in tune with matters concerning generation for electrical purposes by nuclear?

A. It considers all topics nuclear, yes.

Q. And if you would turn with me to page

21. Unfortunately I did cut this off. At the top of the page you will see as the title at the beginning of the document says "The common commissioning date of 1995 was adopted for compatibility with the UNIPEDE study which is a prior study which had been done, as you see, in June of 1988.

A. May I interrupt. I think I must have the wrong page. Which page?

Q. Top of page 21. The very top wording. Unfortunately it is cut off from the prior page.

A. I have that now.

Q. And I will make sure you get a full one for the weekend.

But I understand that UNIPEDE has studied this matter of comparative cost prior to Exhibit 531 and has done so for a number of years, the one we looked at before. Would I be correct?

A. Certainly for a number of years. I can't tell you for how many.

Q. Right. And this study was intended to be for the same date of commissioning as the prior study. And if we could then turn to page 25. Perhaps I could take you first to page 26 and then come back to page 25.

You will see in the middle of page 26, the third paragraph says: Data for Canada is similarly presented by the Central Region, where Ontario Hydro is the local utility and for Eastern Canada using data provided by the New Brunswick Electric Power Commission.

And then leaving out the next sentence: Data on electricity generation from coal in Alberta are also presented. And you will see in the tables information from Central region, Eastern and western.

And if you go back to page 25, under the heading "General":

> The data contained in this section were obtained by a means of a questionnaire circulate by OECD member countries by the NEA and IEA secretaries jointly.

And if you drop down one sentence or two:

> Some participants who also contributed data to the UNIPEDE study used the same data and answered the supplementary questions only. In a few cases UNIPEDE returns were modified by countries to reflect their more recent views.

And I would just like to ask you if you

could confirm that Ontario Hydro did provide the information that we will find in this study, if that is possible for you to do so?

A. Well, I can confirm that through external affairs we received requests to complete these questionnaires. I was looking at the front of this report and I wasn't clear what the date of it is unless it is 1989.

Q. '89 yes.

A. I will have to confirm whether Hydro presented information in '89 but I imagine they did. We have certainly received a recent request from OECD to do so for this year.

Q. Okay.

And if we can turn to page 70, I think, just for reference sake to understand the document. Again each country is shown in the various tables as to the kind of station that is being analyzed. And for Central, i.e., Ontario Hydro, you will see it is the CANDU 4 times 881 type of station that was analyzed by UNIPEDE. That would be the Darlington type of station, would it?

A. Yes, it would.

Q. And you will see the date of the cost estimate is 1988 in the right-hand column.

A. Yes.

Q. Now I think we can take the figures in this as read, but the one that I want to spend some time on is Table 9 on page 74. And this table 9 is headed "Composition of Operation and Maintenance Costs". And if you look along the column or across the line, Canada Central, 4 times 881, you will see the total O&M costs stated in U.S. dollars per kilowatt per annum. Am I reading that column correctly on the right-hand side?

A. Yes.

Q. And if you see the number opposite, the 4 times 881, and the 4 times 500, the number is for Canada, for Ontario Hydro, 15.1 U.S. dollars per kilowatthour per annum and 11.8 on the 4 by 500; is that correct?

A. Yes, I certainly see those numbers. I am trying to determine what.... I think I'm fine, thank you.

Q. Yes. And if you compare those numbers to any of the other numbers, they are dramatically less than the numbers shown in Denmark, Finland, France, Germany, Japan, the Netherlands, et cetera, and particularly the United States or the United Kingdom. Would you agree with that?

[3:25 p.m.]

A. Yes. The only comment I would make is that I gave complete historical data on OM&A costs for nuclear power in my direct evidence, and up-to-date.

Q. Yes, but one of the points I am going to spending sometime with you on is Ontario Hydro has been spending, on these numbers, a half of what other countries have been spending on operation and maintenance per kilowatt per annum.

A. We would agree and I testified that as of today we are still only about a half of the United States, yes.

Q. So that the performance that we have seen of the CANDU reactors has been in circumstances in which Ontario Hydro has been spending a half of whatever body else has been spending on their generating units, and notwithstanding that, we have seen the performance that we have seen for CANDU reactors.

A. Well, that is correct to some extent. But, Mr. Heintzman, you should remember that comparisons should be made with similar multi-unit stations, and I think a comparison perhaps with France is nearer the mark then comparing with single unit

stations in United States, for example.

Q. Well, it's my understanding that France and Belgium would you be the best comparison in terms of multi-unit stations in low cost that we saw in the UNIPEDE study.

A. Certainly France would be, yes.

Q. And if you compare France to Ontario Hydro, the French are spending two to three times as much on O&M as Ontario Hydro is.

A. Well, less than two times, from what I can see.

Q. Well, on the 4 times 500 stations at 11.8.

A. I think that's coal-fired, isn't it.

Q. Yes, you are right. I apologize. It's 15.8 -- 15.1.

A. Yes.

Q. As compared in France, 28.3 to 25.7?

A. Nuclear and coal, yes.

Q. And if we turn back to page 28, the authors comment upon this, the last paragraph, saying:

> For all participating OECD countries, except the United States and Japan, the projected O&M cost for both nuclear and coal plants for base load use are below

20 per cent of the overall cost of electricity production. In two cases, Turkey and Central Canada... That's Ontario Hydro, ...the O&M costs for coal plants lie below 10 per cent of overall generating cost.

That's the conclusion that the report came to.

A. That seems to be their conclusion.

I think I testified in going through the costs model that OM&A on the lifetime basis of levelized unit energy cost was about 20 per cent.

Q. If we could turn to table 12 on page 77, again under Canada, the column or the line opposite Central gives us the levelized discounted electricity generation costs, 30-year life time, 5 per cent discount for, as I say Central, which is Ontario Hydro, 19.6 under the nuclear, 26 under the coal, for a ratio of coal to nuclear of 1.33?

A. Yes, in 1989.

Q. Right. And using a 10 per cent discount rate on table 13, the result is a 1.06 cost of coal to cost of nuclear?

A. Yes. At high discount rates, there is little difference.

Q. And if you would turn with me to page 100, and much of what is said by this organization is reflected in your numbers so I don't want to spend too much time on it, but we go down under the heading nuclear to the fourth sentence, it says:

> Tables 2.1 and 2.2 demonstrate the overall nuclear performance for countries contributing to this study. In addition, IAEA's PRIST system reports that more than one-third of LWRs in OECD countries have cumulative load factors up to 1986 which exceeded 75 per cent. Outside of United States half the LWRs were reported to have a cumulative load factor exceeding 75 percentage and those results include French and Belgian reactors where some form of load following has been practiced. In some OECD countries a load factor of more man 90 per cent has repeatedly been achieved. Experience in OECD and PHWRs has also been good.
> A case for using the 75 per cent load factor for future nuclear plants is therefore strongly supported.

Now, if we turn to table 2.1 which we

will find on page 103 we will see the kind of load factors that we saw from the other studies that I put to you this morning historically. And if we look across the line in Canada, we see that the performance in the vicinity of '81, '82, '83, was up around the 86.5 per cent load factor and has dropped off materially since that time as you described in your evidence in chief.

A. Yes. I think Mr. Daly gave that information. I don't know if you want to comment on these figures.

MR. DALY: A. Yes, these are basically similar to the figures that I presented.

Q. And I will be coming back to this, but I think you indicated, both Mr. Penn and Mr. Daly, that the contributing factor to this was the rate at which Ontario Hydro was spending money on OM&A.

A. I indicated that as one of the factors. Other factors included pressure tube failure, and I think I alluded to do a number of others. But certainly OM&A was one of the factors.

Q. And if you look opposite France and Sweden you will see a number which tells us that those numbers should be looked at carefully because it says it's affected in later years by load following. But

the figures for Canada, notwithstanding the problems that we have been having in recent years, are highly respectable in an international setting, are they not Mr. Daly, second only to, I believe, Belgium and the Netherlands and Switzerland?

A. Yes, I think of the figures I presented in my direct evidence indicate that overall on a lifetime basis our figures have been very competitive.

Q. And we have similar information for availability factors in table 2.3. And again, Mr. Penn, subject to your advising us as to the source of information in the study, would you agree with me that that kind of a study is the kind of study that people look to in your industry for reliable figures on comparative figures in the nuclear generation business?

MR. PENN: A. I would agree it's an important parameter, yes.

Q. Thank you. Now, I want to turn for a moment to --

THE CHAIRMAN: I wonder if this is a good time to take a break.

MR. HEINTZMAN: It's a good place.

THE CHAIRMAN: We will take a break now.

THE REGISTRAR: Please come to order.

The hearing will recess for 15 minutes.

---Recess at 3:35 p.m.

---On resuming at 3:55 p.m.

THE REGISTRAR: Please come to order. This hearing is again in session. Please be seated.

MR. HEINTZMAN: Q. Mr. Penn and Mr. Daly, I want to discuss with you - I guess mostly with Mr. Penn - the role of the nuclear option in the DSP, and before we come to that, or as a lead in to it, I have handed to you a presentation to the Ontario Legislature Select Committee made by Mr. Penn in August of 1988. Do you have that Mr. Penn?

MR. PENN: A. Yes, I do.

MR. HEINTZMAN: May that be marked as the next exhibit.

THE REGISTRAR: 534.

---EXHIBIT NO. 534: Presentation to the Select Committee made by Mr. Penn, August of 1988.

MR. HEINTZMAN: Do you have that Mr. Penn?

Q. And this is a presentation which you made Mr. Penn, to the Select Committee in August of 1988?

MR. PENN: A. Yes, it is. I believe it's with regard to the demand/supply planning

strategy.

Q. And if we turn to page 1, I would just like to go through this with you. You, on page 1, say that:

> This presentation is on the CANDU nuclear option. The presentation includes the following: One, the strategy element 5.8 which proposes maintaining the CANDU option.

And that was one of the essential strategy elements of the DSPS?

A. It was one of about 56 elements in the strategy, yes.

Q. Yes. And that was an element which you were in favour of?

THE CHAIRMAN: I am not sure that that's a question that Mr. Penn necessarily has to answer. Is it? Why should have to answer that, whether he is in favour of it or not?

MR. HEINTZMAN: I thought that's what he was telling the Ontario Legislature, that he was in favour of it.

THE CHAIRMAN: Perhaps you should point him to the place where he says that.

MR. HEINTZMAN: All right. The whole

document is in support.

THE CHAIRMAN: He expresses opinions of opinions on matters, but whether he degrees with policy matters, that's not something that he should have to express an opinion on.

MR. HEINTZMAN: No.

Q. Were you expressing the view to the Select Committee that the CANDU nuclear option should be maintained?

MR. PENN: A. I was speaking to the Select Committee with regard to a strategic element that Hydro at that time felt was very important.

Q. Yes. And was it your opinion as an expert in nuclear generation, and you spent all your life in nuclear generation; correct?

A. Yes, I have.

Q. That that option should be maintained?

A. Well, on the basis that I have spent 37 years of my life in this subject, obviously I have some leaning towards it, otherwise I wouldn't have done so. [Laughter]

Q. That's a fair statement. So do I take it then that at the time you spoke to the Ontario Legislature it was then your opinion that the CANDU

option should be maintained?

A. I considered it one of the important strategic elements of the strategy.

Q. And that's still your present view; isn't it?

A. I believe if you are asking me personally--

Q. Yes.

A. --that nuclear power does have a place and is shown in the Update to have a place in the future in this province.

Q. But your opinion as a person who has been involved in the subject matter for many years is that the CANDU option is one that ought to be maintained; isn't it, your personal opinion?

A. I think it would be a great pity if it wasn't.

Q. Yes. And you, at one of the points on page 1, say, as point 6, what is involved in maintaining the CANDU technology as a future option.

A. Yes. This really is the contents of my presentation to the Select Committee, I was trying to tell them what it is I am going to talk about.

Q. Yes. And one of the points you make and you are making in that point 6 is that it is

important to maintain a technology.

A. No. I think what I was trying to do is to describe to the legislative Select Committee what would be involved in maintaining the CANDU technology.

Q. And your opinion was that the technology should be maintained, was it not?

A. The opinion of Hydro at that time was that it was an important strategic element to consider in formulating a strategy which would essentially be the spring board for determining the DSP plan.

Q. Yes. And I am not so concerned about Ontario Hydro's opinion if there was such an animal. I am really concerned with your opinion.

It was your opinion at that time that the CANDU technology was something that should be maintained?

A. On the basis of its success to that time and my long-term involvement in the technology, I was certainly willing and ready to speak on that subject.

Q. And it was your opinion that that was a good thing to have occur?

A. I considered it eminently sensible.

Q. Yes. And maintaining a technology, as I think you have told the Board in chief, is not

something that happens. It's an ongoing process; is that not fair?

A. Maintaining any technology is an ongoing process, yes.

Q. And particularly when it's a new and highly dynamic technology such as nuclear generation; would you agree with that?

A. I think it is not necessarily its newness because, after all, we have more than 35 years of experience. It's more a question of the ownership and the importance of continuous consciousness of safety and economy and reliability, protection of the environment, and all the things that we have spoken of on this panel.

Q. And that's particularly true would you say when the technology is up against two other technologies which are being vigorously redefined and redeveloped and promoted throughout the world?

A. I am not sure which technologies you are referring to.

Q. I am referring to the light water and the boiling water reactors.

A. I agree that it is a very competitive marketplace.

Q. And if you are going to maintain your

technology you have got to upgrade it and advance it. It can't be left to stand if you are going to remain in competition with those two other technologies; would you agree with that?

A. Yes.

Q. And we go then through page 3 and most of the -- some of the pages are overheads that you presented to the Committee, as I understand it.

A. Yes, the format was an overhead presentation with notes to speak to them.

Q. And page 3 again sets out the strategy elements 5.8, which was to maintain the CANDU nuclear technology?

A. Yes. Exactly as written there, the element was that Hydro would seek to maintain the CANDU nuclear so that it is available for future development.

Q. Yes. And the result of that strategy lead to the CANDU "A" project which was under way after this hearing and up to 1990, is that fair?

A. Well, the Select Committee and the Board of Directors of Ontario Hydro who approved the strategy acknowledged in their approval that seeking to maintain CANDU nuclear option was an appropriate thing to do.

The CANDU "A" which of course was a

nuclear project that was named CANDU "A" as the first project in the original DSP, was chosen by our planners together with a whole balance of other options to pursue.

Q. Exactly. So it was the thing that was growing out the strategy as of 1988 to 1990?

A. The definition of CANDU "A" in the DSP didn't just grow out of the strategy. It grew out of a plan that was put together by our system planning division.

[4:05 p.m.]

Q. But it was a plan that grew out of this strategy that we are reading about right here?

A. It was related to it but that in itself was not the reason alone.

Q. Obviously. But it was pursuing that strategy?

A. It was one of the elements, yes.

Q. So if we look over on page 7, you refer to the CANDU performance as one of the reasons for the presentation you were making to the Select Committee?

A. Yes, one of the characteristics of the option, yes.

Q. And do those characteristics remain

correct?

A. Are you talking about the quantitative value of the characteristic or just the fact that performance as a characteristic is an important subject?

Q. No. What you describe here is basically the case still today; isn't it?

A. Well, it is still true that CANDUs together with certain of our hydroelectric plants supply base load electricity to the province.

Q. Yes. And that nuclear power represented 33 per cent of the electrical capacity in Ontario --

A. At that time it did. It now represents 43 per cent.

Q. Yes. And after 1993, will the percentage of delivery equal the 65 per cent that you referred to in the last paragraph?

A. If I remember correctly, my evidence in chief said it would be 62 per cent when Darlington was complete.

Q. So what we have on page 7 here remains substantially the same?

A. Yes.

Q. Then let's turn to page 9. Do the

remarks that you make there on page 9 still apply today concerning CANDU performance and public safety?

A. Clearly we now have about another 35 reactor power years or more of experience.

Q. So we are over 191?

A. Mr. Daly might be able to help me there.

MR. DALY: A. We are slightly over 200.

Q. Slightly over 200. And it says there has never been a radioactive related fatality or injury to any member of the public. Does that remain true?

MR. PENN: A. That was our testimony two days ago.

Q. And the rest of the document on that page, does it remain true updated to today where necessary?

A. Well, I think that the third from last comment:

> "We are not taking the future for granted. We must insure that public risk is kept to a minimum...."

is very true today as it was then. And I think the next one:

> "Although nuclear power cannot be assumed to be risk free in the future,

that is true of every human endeavour...."

et cetera, is also very true today.

Q. We have every reason to --

A. And the last one is particularly of concern to Ontario Hydro.

Q. Yes. But the sentence second from the last:

"We have every reason to believe that the total public risk from CANDU nuclear power will continue to be lower than most, or all, energy alternatives."

remains true today, does it not?

A. I am sure that there would be a number of views on that subject. I believe that that statement is reasonable.

Q. Let's look at page 11, CANDU performance: Worker safety. And we are up to more than 145 million person-hours. I am not sure what the number would be today. Do you know, Mr. Daly?

MR. DALY: A. Probably around 160, 170.

Q. Million person-hours?

A. Yes.

Q. And do the statements on that page remain true today?

MR. PENN: A. We have never had a fatality in operating a CANDU, that's correct.

Q. No employee has ever been injured by radiation?

A. Maybe Dr. Whillans would like to bring this up to date. I am not sure that I am qualified to --

DR. WHILLANS: A. I think I would have to ask you what you mean by injured.

Q. I guess I would have to ask Mr. Penn what he meant by injured. [Laughter].

MR. PENN: A. I think what I meant by injury there was that no one had a dose that exceeded the limit under regulation from the Atomic Energy Control Board during the operation of the plant.

Q. Does that remain true, Dr. Whillans.

DR. WHILLANS: A. Sorry, I think I would have to ask Mr. Penn to repeat that. Did you say that no employee had exceeded the legal dose limit?

MR. PENN: A. That's what I said, yes. At that time.

DR. WHILLANS: A. I think in my evidence I mentioned that there were a number of people over the years who had exceeded the annual limit, but had not been injured in the sense I take him to mean. And

that's particularly true with respect to the rest of the paragraph. There were no excedances between 1979 and '89 to my knowledge.

Q. And the next paragraph goes on to say:

"We have had impressive safety records with our coal and hydro stations, but our nuclear has been the best."

Is that a correct statement still today?

MR. PENN: A. With regard to severe injury, yes, of a physical type.

Q. This is directed toward worker safety so I take it that remains true?

A. Yes.

Q. And you end that by saying:

"No major industry in Canada has such an impressive record. The bottom line is excellent performance."

Does that to your knowledge remain true today?

A. That's based upon the Ontario and Canada worker safety annual reports.

Q. And then page 13, CANDU performance environmental protection. Do those remarks remain true today?

A. Certainly paragraph 1 does. And paragraph 2 does. I think our testimony, by Mr. Johansen in particular, testifies to paragraph 3.

Q. Yes. And as I understand it, Mr. Johansen, that the radiological emission standards are set conservatively and fall within international and Canadian standards; is that correct?

MR. JOHANSEN: A. That's right.

MR. PENN: A. I think paragraph 4 we have repeatedly given testimony to the fact that we are generally below 1 per cent of the derived emission limit.

Q. And the last paragraph?

A. And the last paragraph is explaining why: that in fact we have containment systems; we have special ventilation systems.

Q. What the last paragraph is saying, it says:

> "They have contributed to the significant acid gas and carbon dioxide reductions, due to their presence in the electricity generating station."

That remains true today as it was in 1988?

A. On the basis that if we hadn't built

nuclear and we had built fossil, then obviously our emissions would have been much higher.

Q. Yes. And we will be coming back to this. But in one of your documents you show that during the lifetime of all of the plants, there will be 75,000 tonnes I think of used uranium fuel. Do you recall that document? We will come back to it in Exhibit 519.

A. Yes, I do recall it.

Q. The thing about nuclear generation is that the 75,000 spent uranium, used uranium, is there and identified? That's what you are saying here; isn't it?

A. Well, you could read that into it and yes, they are in a special place and they are identified, yes.

Q. And there they are and that is the emissions that the plant has produced. Whereas, in another sort of generation such as fossil, we will see the products are in the environment and loose in the environment?

A. Well that's one of the emissions. That's a solid emission if you like. There is of course other emissions that Mr. Johansen testified to.

Q. Yes. But dealing with solid

emissions as opposed to fossil where you have CO(2), you have SO(2), you have ash, those products are in the environment. Whereas what you are saying in this paragraph is that CANDU stations are canned plants and retain their products of combustion aside from the radioactive emissions that Mr. Johansen referred to. That's the point you are making there, isn't it?

A. The nuclear plants certainly do contain the products of combustion within the fuel assemblies, yes.

Q. And then on page 15, Reliability. Do those, subject to what you have told me and indeed you speak of it in paragraph 4 on page 15 under CANDU performance reliability, do those comments remain true today as they were in 1988?

A. I think that they exactly parallel what we have testified at this hearing.

Q. Page 17, CANDU Performance: Electricity Costs. Do those comments, subject to what you have described as a narrowing gap between nuclear and fossil generation, remain true today?

A. Which paragraph are you referring to, please?

Q. The whole of page 17 under the heading CANDU Performance: Electricity Costs.

A. I thought I had heard you talk about narrowing of costs between fossil and nuclear. That's why I asked the question.

Q. You have told us that there have been some narrowing of those costs?

A. Yes, I did.

Q. This page refers to the advantage which nuclear has over other costs. And subject to the narrowing, what I was suggesting to you or asking you is whether these comments remain true today that we see on 17?

A. I am not quite sure whether the statement I have made in the first paragraph that "Total Unit Energy Cost (TUEC) of producing electricity from CANDU stations in Ontario is the lowest nuclear cost in the world." I think it's very close to being the lowest but I am not certain that it is the lowest.

Q. Well, those UNIPEDE studies show it is certainly one of the lowest or the lowest that we looked at before.

A. Well, The UNIPEDE studies refer to future plants.

Q. Yes, true.

A. I am talking about existing plants.

Q. Well, subject to it being one of the

lowest, if not the lowest, that paragraph would remain true.

A. That's what I am saying, yes.

It is certainly true that of all nuclear reactors, CANDU reactors have the lowest fueling costs because the fuel is natural uranium.

Q. The third paragraph --

A. It is certainly true of the third paragraph because I have done it for the last six years and I don't suppose it will change this year.

Q. And that's referring to review by the Ontario Energy Board?

A. Yes. I have already testified that at this point in time we can't claim that nuclear shows a 30 per cent advantage over coal-fired stations.

Q. But we will come back to it in a moment. The nuclear stations are still the lowest cost comparing apples with apples to --

A. They are still lowest but they are not as low as we would like them to be.

Q. They are not as low as they were at the time that this report was delivered?

A. That's correct.

Q. And the last paragraph talks about the LUEC.

A. Well, it is true that with the exception of Sir Adam Beck 3 that nuclear levelized unit energy costs are lower than hydroelectric. But I have to qualify that statement by saying that you really can't compare the two because the capacity factors are so different. And I think this is a matter that you should discuss with the next panel, Panel 10, who are experts on that subject.

Q. Well, we will certainly do that. But it still remains true that subject to the propriety of comparing based upon capacity factors, this paragraph remains true today.

A. I think Mr. Snelson has given testimony that you can't compare LUECs unless capacity factors are the same. This is a fundamental. So I would refer you to direct that matter to him, and I know he is a witness in the next panel.

Q. Well, Mr. Snelson was supposed to be a witness on this panel and was listed as such.

A. I guess they thought I could do the job so they gave him some rest.

Q. That's why I am asking you the questions.

So that subject to Mr. Snelson's view as to whether you can compare LUECs based upon different

reliability or capacity factors, this paragraph remains true: that nuclear is less expensive than hydro?

A. Subject to that understanding, yes.

Q. And does that apply to the proposed hydroelectric projects as well?

A. Well, I was referring to the proposed hydroelectric projects when I made may earlier comment.

Q. So the only one you would exempt from that is the Sir Adam Beck element; is that what you are saying?

A. Sir Adam Beck 3 has considerable economic promise.

Q. Page 19, Nuclear Safety. Do the remarks that you make on that page remain true today?

A. Well, I asked Mr. King - I did have a chance to glance at this one - whether he would back me up.

Q. Well, I assume that anybody will chime in when and if they want to. Mr. King?

MR. KING: A. Yes, I have just glanced at this first paragraph, if that's what you are referring to. And given that these are what I understand to be just notes that Mr. Penn was using to make an oral presentation speaking to his overheads here, the first sentence is certainly true; the second

sentence is certainly true, today; the third sentence is certainly true.

I assume in the fourth sentence Mr. Penn was referring to significant consequences of accidents being limited to the station, and if that's what he was referring to, then that's true today.

And the last part of that sentence, "...the probability of events occurring with any serious consequence is reduced to less than one in a million chance." Again if he was referring to serious off-site consequences, I believe that this would be true today and the Exhibit 529 which you presented to me earlier this afternoon, the paper, I believe there are numbers in there which would support that: that the frequency would be less than one in a million per reactor year of operation.

If you want me to continue to the next paragraph --

Q. Starting with the words, the Atomic Energy Control Board?

A. Yes.

Q. That paragraph is correct today?

A. I believe so.

Q. The next paragraph?

A. The last sentence, "All found CANDUs

acceptably safe." They all didn't use that exact terminology but in that general sense I would certainly agree with that.

And the fourth paragraph, that I believe is an exact quote from the No. 1 conclusion of the Hare Report.

[4:25 p.m.]

Q. Again, on page 21, Mr. Penn, or maybe Mr. Johansen, it sets forth the reasoning behind the heading Irradiated Fuel Management and Disposal.

Do those remarks remain true to date?

MR. PENN: A. The first paragraph is a statement of fact which Mr. Johansen testified to earlier this week.

The second one is a defined responsibility of Ontario Hydro for the interim storage and subsequent transportation, and we also gave testimony on that.

Both Mr. Johansen and I stated again at this hearing that we can safely store irradiated fuel in our pools for 50 years or more. This has been shown by experimental and continuous operation of fuel under water.

It's a part of the agreement between the federal government, the Province of Ontario and Ontario

Hydro that Atomic Energy of Canada Limited is responsible for the design of waste immobilization in the final disposal facility.

I did testify that extensive studies and experiments have been performed over the last 10 years and will be reviewed before the Federal Environmental Review Board.

We have made cost provisions for the disposal of our irradiated fuel and I testified how much those provisions had now amounted to. I think, if I recall the number, about $386 million to date.

The federal Minister of the Energy, Mines and Resources has set in place the process to review in a public sense the technological concept of disposal, and this must be done and agreed to before there is any follow up of any possible site selection studies and subsequent public environmental review.

It is now not correct that the facility will be in-service after the year 2010. Hydro Board of directors took the decision that it should be moved to 2025 as being a more practical date given the many considerations of this important matter.

And I guess I was inviting the Committee, if they wanted to know a lot more about this subject, to tell me.

Q. So aside from the in-service date for the disposal facility, the remarks on that page remain correct today?

A. Yes, they do.

Q. Page 23, Ontario Benefits From Existing CANDUs to 2010. Again, if you can just look down that page and confirm that those remarks remain true today?

A. Well, certainly before 1988 the direct benefits of the existing nuclear program were large compared to an alternative of burning coal on our system. As we have testified, this gap is closed or closing. So there is a modification of that paragraph.

I haven't personally done any calculations since this presentation to my knowledge on the accumulated benefits and this is a matter that I think Panel 10 would best address because we are making comparisons here between systems and they are the people with the system knowledge of these alternatives.

Q. I am going to come back to that in some other documents. But subject to that, those two facts, the narrowing of the differential between nuclear and fossil, and the more accurate calculation of the reduction in foreign content by using fossil as opposed to nuclear, the remarks on that page remain

true today?

A. I think the province has benefited and I think it's been stated on many occasions in the past, has benefited from nuclear power relative to other alternatives from a financial point of view, and I hope they continue to do so.

Q. And you list them at bottom of the page, reduced electricity costs, reduced rate increases, reduced coal imports, reduced toxic emissions, and balance of trade with the U.S.A. Those are the advantages?

A. Those were the advantages. I think the circumstances today are somewhat different. We are, for example, purchasing more coal from the United States than we had been, and I think our chairman made a recent announcement of that matter. Although I am no expert, I am not in the fuels division and I only read what the chairman talks about.

Q. Well, to the extent that that is occurring, these benefits that you have referred to here are being depreciated?

A. I am sorry, did you say they are being depreciated?

Q. To the extent that the U.S. coal is being purchased and being burnt, there are more toxic

emissions, there are higher coal imports, and the balance of trade with the U.S. is not as favourable under this document that you --

A. I don't think I could comment on whether it's more or less favourable. I don't know. But if in principle you are saying, well, if we burn coal, we emit carbon dioxide, I have to agree with you.

Q. Let's go on to page 25, and I think that's a subject that maybe we can let others speak to, U.S. versus Ontario electricity rates unless you have or anybody else has anything to add to that statement.

A. I don't personally have anything to add to it, but I did note that last week's Hydro Scope, which is Ontario Hydro's newspaper for its employees, has an article on the second page on it and I refer it to you.

Q. We will obtain that. Can you get us a copy?

A. Well, I will ask one of our staff to pick up a copy and bring it in on Monday.

Q. Thank you.

Page 27 CANDU, an indigenous industry, do your comments there remain correct today?

A. I don't mind talking personally and say that I believe as a Canadian that the CANDU

technology is an achievement.

Q. A remarkable achievement?

A. It's certainly an achievement, and I think we stated earlier that it was recognized as an engineering award by the nation some time ago.

Q. And the balance of that page remains true?

A. CANDUs, apart from the steam turbine and a few other components, are mainly built in Canada, and particularly in Ontario.

I believe the figures today in the table would be similar, they may be slightly less, but they are of that ballpark.

I have already testified that there is abundant uranium in Saskatchewan. There is a lot of uranium in Ontario. Unfortunately it doesn't occur in nature in Ontario at the high weight per cent concentration.

Q. To the extent that the contracts with Elliot Lake are terminated or come to an end, the cost of fuel will substantially decrease for Ontario Hydro?

A. I testified by 1996 there will be about half what the fueling cost is today.

Q. And in the LUEC numbers that you submitted for the nuclear options, have you assumed,

particularly for 1991 dollar figures we will be coming to, have you assumed the Elliot Lake contract figures or have you assumed the world price uranium figures?

A. Well, neither. And I would have to check this, we would consult our fuels division and obtain their 15-year fuel index data in order to do those calculations.

Q. Could you let me know whether they used the Elliot Lake contract figures or the world price figures, or what they used in order to project the LUEC figures that are shown on page 81 of Exhibit 519?

A. Well, Ontario Hydro has always purchased uranium from a number of suppliers, so it won't be a matter of just using the Elliot Lake or Saskatchewan. It's a mix.

The only issue here in my mind is whether the fuel indices that were used, took into account the future cancellation of these two contracts. I don't know that answer.

Q. Would you find that out, and if so, to what extent and if not, what impact that has on the LUECs that are set forth on that page?

A. Well, of course they won't have very much because the fueling cost at most is only 6 per

cent of LUEC. It will be a fraction of 1 per cent, I would suggest to you, Mr. Heintzman, but I will check it out for you.

THE CHAIRMAN: That will be undertaking 532.2.

MR. HEINTZMAN: Thank you, Mr. Chairman.

---UNDERTAKING NO. 532.2: Ontario Hydro undertakes to determine whether the LUEC figures page 81 of Exhibit 519 are based on recent changes to the uranium fuel contracts.

MR. HEINTZMAN: Q. Now having reviewed Exhibit 534, Mr. Penn and Mr. King, I would like to turn to the DSP which was generated by the DSP strategy that you were discussing with the Legislature.

MR. PENN: A. I'm sorry, Mr. Heintzman, I was trying to write down the undertaking.

Could you refer me again to the document?

Q. Yes, Exhibit 3.

A. Yes.

Q. It was a product of the DSP strategy which you were setting forth the advantages of to the Legislature in Exhibit 534.

A. Well, I was one of the Hydro staff that made presentations.

Q. Yes, I am not going put it all on your shoulders.

But you amongst others, and you particularly in Exhibit 534, were describing the benefits of the DSP strategy.

A. We were explaining Ontario Hydro's strategy to the all party Select Committee.

Q. Yes. And that strategy lead to Exhibit 3, the DSP, Balance of Power?

A. The strategy was used by system planning and corporate programming divisions as guidelines to help formulate the plan.

Q. Yes.

A. But only one set of documents. This was one part of the process.

Q. Yes. Well, I appreciate that you have told me that the DSPS was one thing that lead to CANDU "A", and the DSPS was one thing that lead to Exhibit 3. Is that what you are telling me?

A. Yes.

Q. And in the DSP, Exhibit 3, nuclear generation is set forth as the preferred alternative for base load power; correct?

A. I'm not sure. I don't remember every word in this document and I don't know whether the words "the preferred alternative" for base load power is nuclear. It's certainly one of.

Q. Well, Plan 15 and various other plans are set forth as being the alternatives that are going to be examined for selection in this document. You are aware of that.

A. Well, as a person that wasn't involved in actually writing this document but was involved in supplying basic information, I think what you have said from my understanding of this document is right, but I would like to qualify it with those comments.

Q. Fine, that's satisfactory.

[4:40 p.m.]

And in selecting nuclear generation as the preferred alternative for base --

THE CHAIRMAN: I am not sure quite what you mean when you say that as a remark of the DSP.

Certainly nuclear generation was part of the plans but in isolation as a preferred alternative it may be, but I don't recall that being said specifically in the DSP.

MR. HEINTZMAN: Well, we can go through the document. We did this on previous occasions. In each alternative scenario, the plans, plan or Case 15, Case --

THE CHAIRMAN: There is no doubt that

nuclear generation is an element in each of the plans set forward. I am not quarreling about that. You seem to suggest by your question that nuclear generation is preferred to any other type of generation and I don't recall that particular statement. Certainly its utility is in base load generation; that statement is there. But base load generation is only part of the whole system.

MR. HEINTZMAN: Absolutely. The question was premised to Mr. Penn when I said that the DSP is based in respect to the base load generation on selecting nuclear generation as the best alternative for base load generation. I am not talking about other generation.

Q. That's what this report says; isn't it? With your caveat that you weren't involved and you are just reading the document and you supplied the information for it, but that's the conclusion that this report comes to?

THE CHAIRMAN: I guess it's semantic, but I don't remember them saying preferred. I do remember them saying that nuclear generation is useful as base load generation, but I didn't get, necessarily, that it was the only way you meet base load generation --

MR. HEINTZMAN: No, no, no.

Q. Well, perhaps we can go through this. But in chapters 14, 15, 16, and 17, various components for the plans are set forth. You have to have some peaking power, you have to have some intermediate base, intermediate power, and you have to have base load power?

MR. PENN: A. Yes.

Q. And this report analyses what you should have for each of those ingredients in the overall case. And if we look, for instance, at page 15-34-35 of Exhibit 3, the various components of a case are analyzed.

A. Yes, they are all cases. I would point out that Case 26 is a non-nuclear case.

Q. Yes, exactly. And the cases went from non-nuclear involving coal generation on the one hand to heavy nuclear on the other hand and selected Case 15, which uses nuclear for base load generation and doesn't use nuclear for intermediate load and peaking load.

A. Well, as you have quite rightly pointed out there were five cases and our planners in putting together this document, I believe said that the preferred plan was Plan 15.

Q. Yes. And one of the primary reasons

that they selected Plan 15 was that it contained nuclear generation as the base load component of the plan?

MS. HARVIE: Mr. Chairman, that is clearly a question that should be put to Panel 10. The reasons for the selection of Plan 15 in '89 and the reasons for the update are clearly planning questions that these witnesses should not be asked to answer.

MR. HEINTZMAN: Well, Mr. Chairman, I have a panel of people here who are experts in nuclear.

THE CHAIRMAN: But in looking at major supply options base load, there is CSCs, CANDUs, hydraulic and so on. There is a whole range of generation that is used for base load besides nuclear.

MR. HEINTZMAN: Sorry, what page are you looking at?

THE CHAIRMAN: I just happened to find it at 15-2. It is Table 15-1. So while I was looking for what, I didn't quite pick up what Ms. Harvie.... but the gist of what she is saying is right. These witnesses are not here to talk about the planning decisions that were made either in the DSP or in the update and what the basis for the choices were, but they are here to talk about the characteristics of this particular option.

MR. HEINTZMAN: No question about that, Mr. Chairman, but in my submission I am entitled to ask these gentlemen what their understanding of the DSP is from a nuclear standpoint and I can then ask them questions concerning the nuclear component of the DSP in that fashion. And it is impossible to deal with this issue in Panel 10 unless I analyze these issues with witnesses from this panel in exactly the same fashion as I did in Panel 8 with thermal witnesses and you ruled that that is quite an appropriate question.

THE CHAIRMAN: Well, that's right. I mean I am not -- I kind of got into this when I was looking for something else, so I may not have quite a grasp on the issue.

But in general you can ask these witnesses any questions you like that are relevant to the entire inquiry. And if they can't answer it, that may be one thing. But you are entitled to ask them any questions about anything, including Panel 10 matters or hydraulic matters or whatever -- I hope you don't go too far, but strictly speaking you are entitled to do that. And if they don't know the answer, then that's the end of it. You have to accept that.

MR. HEINTZMAN: Exactly. So I would like to pursue the questions.

Q. Now what the Chairman has referred to us on page 15 -2 are all of the various kinds of generation that you might use for base load or intermediate load or peak load as we see on the right-hand side. Is that correct, Mr. Penn?

MR. PENN: A. That's what the table says, yes.

Q. And it then tells us which options are suitable for which kind of application. For instance, if we look across the nuclear line, we will coming back to this, we see an asterisk under the heading "Intermediate" and we see another asterisk under the heading "Base". Do you see that?

A. Yes, I do.

Q. So we are being told at this point in the report it might be an appropriate planning or generation, if I can use your specialty, option to use nuclear for intermediate load and it might be an appropriate alternative to use it for base load.

A. Well, I want to try and be helpful. But going back to page 15.1, it says:

> "The characteristics of the seven options selected for incorporation into plans are summarized in Figure 15.1."

So what the figure is giving is the

general characteristics.

Q. Exactly. And what I am saying is that what this report then does, starting here, is analyze which options should be selected for base.

A. No, I don't think it is analyzing which will be selected for base. It is just stating what the characteristics are of all these types of generation, and it says that:

"For example, fossil generation CSC using U.S. coal can either be used for mediate, intermediate or base load generation."

It just says the option is capable of doing that and it says also the combined cycle is capable - I'm sorry, phased IGCC, integrated gasification combined cycle, can be operated in peak or intermediate mode.

Q. Yes.

A. And nuclear can be operated in intermediate and base load and we have previously testified to that.

Q. Yes, exactly. So what the authors are telling us at this point is that these are the options. And what happens after page 15-2, through the balance of chapters 15, 16 and 17, is a discussion as

to which of these alternatives is preferable for peak, intermediate and base load. That's what this report is all about in the --

A. Well, I don't think it's saying which is preferable. It's saying which can operate that way. And then it ends up, as I understand it, and it has been some while since I have read this. It is ending up by listing as we looked at before the five different options.

Q. Yes. And ends up with five different options. And then it selects --

THE CHAIRMAN: Well, just to keep the nomenclature. Five different cases; isn't that right?

MR. PENN: I'm sorry, Mr. Chairman, quite correct.

THE CHAIRMAN: Don't apologize. But in this plan, options are one thing and cases can be something else.

MR. HEINTZMAN: Q. And it then selects Case 15 as the preferable case or plan?

MR. PENN: A. Yes, I believe it argues somewhere in here why Case 15 is the preferred case.

Q. Yes.

THE CHAIRMAN: But you are not going to ask him questions about that, why 15 is the preferred

case, are you?

MR. HEINTZMAN: No.

THE CHAIRMAN: That's Panel 10.

MR. HEINTZMAN: I am not going to argue with him about it.

Q. I am going to get him to acknowledge, which I think he has already done so some fifteen minutes ago, that in selecting Case 15, this document is telling us that for base load general -- the reason it selects Case 15, so far as base load is concerned, is because it selects nuclear generation as the preferred alternative for base load generation.

MR. PENN: A. I don't think so. I don't really know. I can't call to mind all the reasons why Case 15 was selected as the preferred case. But I am quite sure amongst them that there was the question of the unit energy costs that would occur through using this particular blend and balance of different options.

There would be the question of the impact on rates, there would be the question of the impact on borrowing, and all the other things that planners get into to make their recommendation. And I am afraid that I can't really testify on all those different things because I wasn't involved in doing it.

Q. Well, what I will do is I will go

over the document on the weekend and we will just continue this discussion on Monday, but let's go through the individual ingredients involved.

The first one in making that selection is it was certainly clear from this report and your information provided to its authors that nuclear generation from a cost standpoint was the least cost alternative for base load generation?

A. For base load generation at the time, yes.

Q. And it remains today the least cost alternative and therefore the preferable choice for base load generation from a cost standpoint?

A. I believe I testified that, for example, an improved 4 by 881 would have a 10 to 15 per cent lifetime advantage if on a pure example basis it went in service in 2002.

Q. Well, all of your examples are on a hypothetical basis to that effect? You hypothesize --

A. We select a year and we do the calculations, yes.

Q. And in fact the 4 by 881 Darlington on page 81 is no longer the least cost nuclear alternative. The CANDU 9 on a 4-unit station is a lesser cost alternative to the 4 by 881 Darlington-type

station?

A. Based on the information we have received from the vendor and assuming that the assumptions on the economy of scale that have been assumed, the answer is yes.

Q. So that comparatively speaking on a cost basis, we now have another option, CANDU 9 option, which wasn't analyzed and dealt with in the DSP which turns out to be a lesser cost alternative than the 4 times 881 Darlington-type station?

A. Well, it wasn't available when the DSP was put together.

Q. I appreciate that. But that is an additional factor in favour of nuclear generation that wasn't available at the time of the DSP?

A. It is an additional factor, yes.

Q. All right. And these are all set out at page 15-71 -- sorry 17-17 of the DSP, starting on 17-15. The second --

A. Did you say 17-15?

Q. 17-15.

A. Thank you.

Q. Where down the bottom right-hand corner, the authors, having had all of this information on all these alternatives available to it, make their

determination that Plan 15 is the best case, and they do so at the bottom of page 17-15 and over onto 17-17? [4:55 p.m.]

A. Yes, that's what the document says, yes.

Q. Insofar as the discussion in here relates to base load generation, they are talking in the case of Case 15 of nuclear generation, because that's what Plan 15 selects.

A. Yes, it did.

Q. So, the environmental criteria that drives the DSP to selecting Plan 15, looking at the environmental aspect, it's because the nuclear generation provides the best environmental impact to the comparable alternatives.

A. Well, I'm sorry, I don't know what the title of this particular chapter is, I think I should find out.

Q. That's a good idea. Demand/Supply Plan, starting on page 17-1.

A. Well, you were referring to environmental advantages, and, I'm sorry, I was confused because I didn't know how that had crept in to the discussion.

Q. Well, you see, the authors go through

all of the criteria that they choose to judge the plans by, starting at the bottom of page 17-15, the 25 plan costs, costs beyond 2014. You and I have discussed costs.

A. Yes.

Q. Then they go to electricity price and borrowings.

A. Yes.

Q. And then they go acid gas emissions, CO(2) emissions, balance of trade, et cetera.

A. Yes, I understand now.

Q. And based upon all of those, they say on 17-17, Demand/Supply Plan 15 is selected as it achieves balance in both a quantitative and qualitative sense, et cetera.

A. Yes, that's what it says.

Q. Which meets the forecast of future customer needs for electricity while providing reliable, low cost power in an environmentally acceptable manner.

All I want to do is discuss the nuclear component. The reason that insofar as base load power Plan 15 was selected was - even though it was the second criteria I am putting you, that is impact on the environment - these factors of reduction of acid gas

emissions, CO(2) emissions were considered by the authors to make nuclear power the preferred option for base load generation; right?

A. Well, I think you are partly right, but I think it's connected with the whole balance of the plan, relative to the balance of the other acceptable plans. That's really what this analysis is all about. It's not specific to nuclear at this point.

Q. You and I have agreed, Mr. Penn, that so far as base load generation, Case 15 selected nuclear generation for base load.

A. Yes.

Q. All right. And the reason when they came to select Plan 15, so far as base load and so far as emissions and impact on the environment, the DSP selects nuclear over fossil because of the impact in the environment.

THE CHAIRMAN: I think you two are going to have to agree to disagree. You say that's so and Mr. Penn says it's a mixture and you can't look at the option in isolation. You're like two ships passing in the night.

So, this being five o'clock, I think we should stop and we can start again on Monday morning at ten o'clock.

MR. HEINTZMAN: Thank you, Mr. chairman.

THE REGISTRAR: This hearing will adjourn until ten o'clock Monday morning next.

---Whereupon hearing was adjourned at 5:00 p.m., to be resumed on Monday, March 30, 1992, at 10:00 a.m.

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E R R A T A
and
C H A N G E S

To: Volume 87

Date: Tuesday, December 3rd, 1991.

Page No.	Line No.	Discrepancy
vi & 15454		2.26.206. s/r 6.26.206.

Volume 97:

v & 17158		2.7.222. s/r 2.7.22.